Chesapeake Bay Program Phase 6 Watershed Model Webinar

Dave Montali – WV DEP – Modeling WG Co-Chair Gary Shenk – USGS - Chesapeake Bay Program Matt Johnston – UMd – Chesapeake Bay Program 7/7/16

This information is being provided to meet the need for timely best science. The information is provided on the condition that neither the U.S. Geological Survey nor the U.S. Government shall be held liable for any damages resulting from the authorized or unauthorized use of the information.

Partnership Feedback on Modeling

- Water Quality Goal Implementation Team
 - Need more transparent and easier to understand decision-support tools to enable successful engagement of local partners



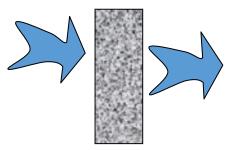
- Multiple Models
- Phosphorus
- Conowingo
- WSM and WQSTM reviews coming



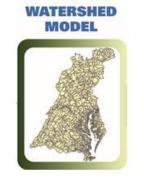
Goals for Phase 6

Understandability

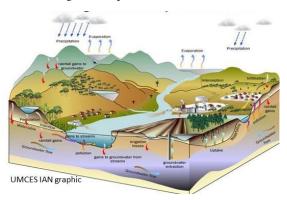
Simple explanation but not content



Build upon Current Knowledge



Refined Geographic Scale



Multiple Models







Accessibility



Phase 6 WSM Improvements

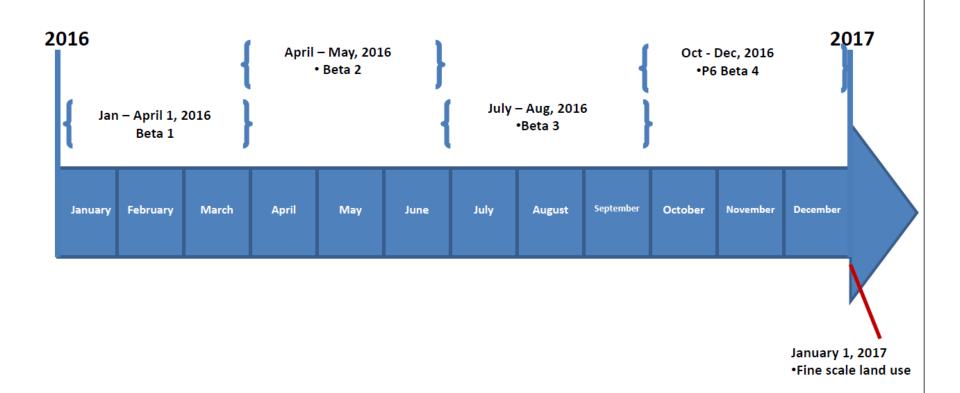
- Extended simulation time period
- More stations and many more observations
- New land uses and relative loading rates from WQGIT WGs
- Improved inputs
- Inclusion of loading lag times
- More transparent N simulation
- New TP simulation approach
- Conowingo simulation
- Reduced dependence upon Regional Factors

Documentation



- See MWG Webpage
- http://www.chesapeakebay.net/groups/group/modeling-team
- Will be periodically updated
- Webinars here too

2016 Phase 6 Model Review Timeline



Reviews

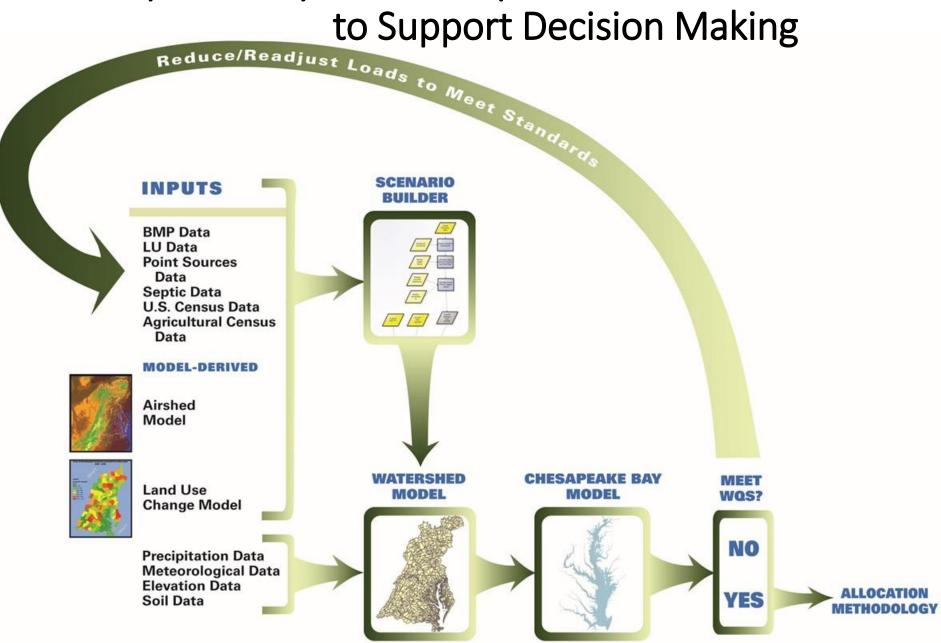
STAC Reviews

- Scenario Builder / Nutrient Inputs (summer)
- Watershed Model (fall)
- Estuarine WQSTM (winter)

Partnership Review

- Started with 2012 WQGIT F2F and BBBM workshop
- Continual work in MWG, WQGIT, and all WQGIT WGs
- Prototypes and Beta versions
- Beta 4 will have all changes except for land use
- Final model review April May 2017
- WQSTM being reviewed by MWG during this period

Chesapeake Bay Partnership Models to Support Decision Making













Phase 6 Model Structure

Average Load + \triangle Inputs * Sensitivity **Land Use Acres BMPs** Direct Loads **Land to Water Stream Delivery River Delivery** Phase 6

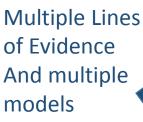


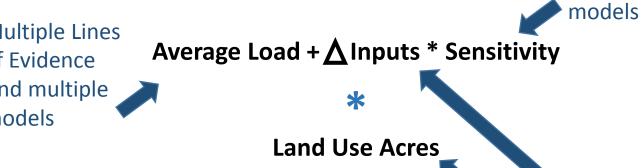


















BMPs





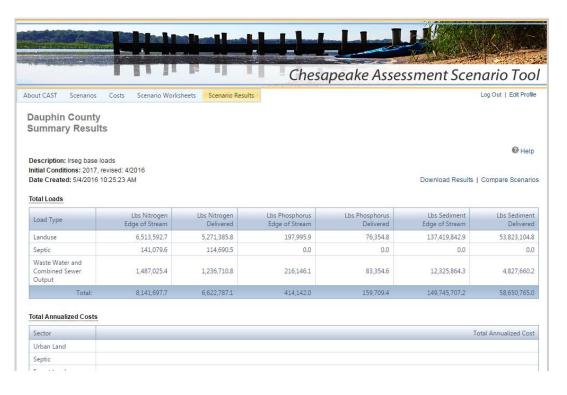
River Delivery

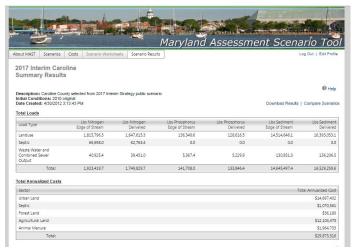
Simulated in HSPF Calibrated with data, WRTDS, and Sparrow Multiple

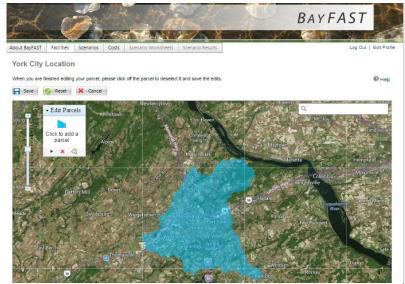
Scenario Builder

Nutrient Models Calculation **Science Quality** Setting Nitrogen Loads and River Flow to the Bay Delivered Load from a land use = **Avg No BMP Nutrient Load** Sensitivity * Change in Inputs **SPARROW SPARROW** For Phosphorus For nitrogen: Soil, slope, Land to water Soil, vegetation, and climate and climate variables variables Review Process Water Quality Goal Team Effect of BMPs **BMPs** Potential models from USGS and Sparrow the Center for Watershed Protection **Stream Delivery** Δx Figure 1. Spatial structure (in plan view) of a 1-dimensis "valley-averaged" suspended sediment routing model. Chesapeake Bay Watersheck The Piedmont and Valley and Ridge Provinces. Chesapeake Bay Watershod: The Coastal Plain Province **HSPF** this study **River Delivery** >10 and <13 years >50 years >7 and <10 year BA1, VOL1 apply

On-Line Tools



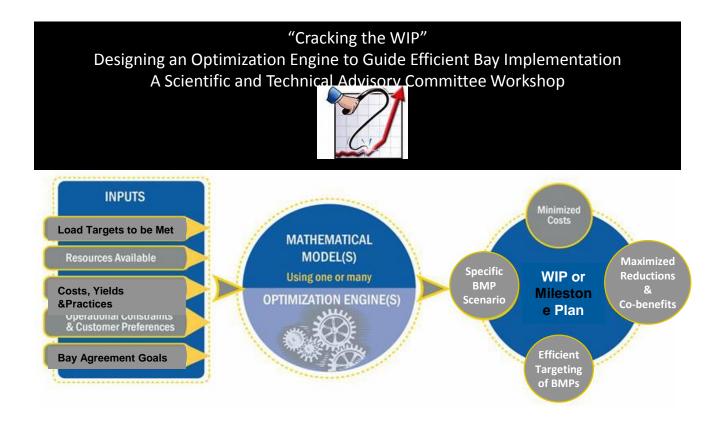




Slide from Olivia Devereux

OPTIMIZATION Calculation Engine

Users input objectives, tool outputs BMPs in the plan that maximize effectiveness at minimum cost.



CBP Watershed Simulation

Data

Logic

Engines

BMPs Land Nutrient Census of **Physical** availability cover Agriculture characteristics **BMP BMP** Nutrient Sensitivity to Watershed Land **BMP** Nutrient **Processes** use Land location effect Application calcula use Input change tor

Tools

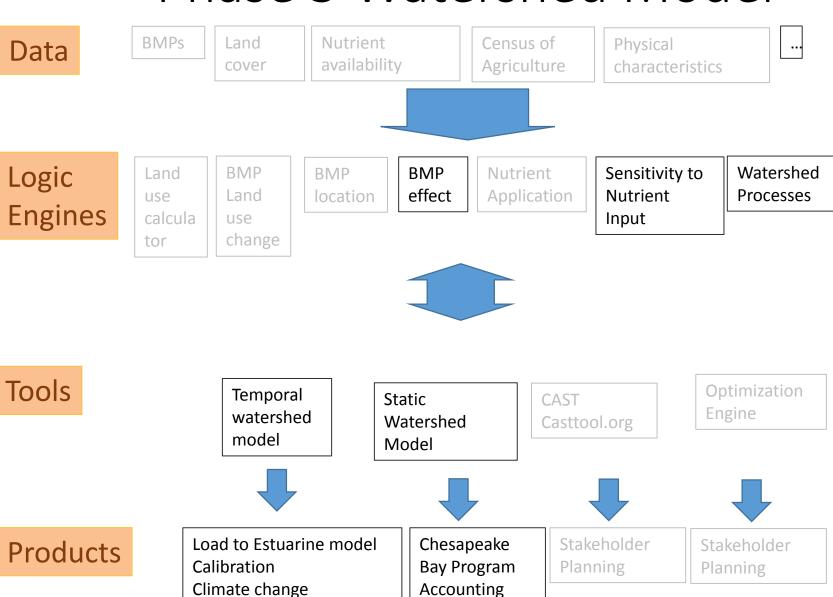
Optimization **Temporal** Static **CAST Engine** watershed Watershed Casttool.org model Model Stakeholder Load to Estuarine model Chesapeake Stakeholder Calibration **Bay Program Planning Planning** Climate change Accounting Lag Times

Products

'Phase 5 Scenario Builder'

BMPs Nutrient Census of Land **Physical** Data availability cover Agriculture characteristics Logic **BMP BMP** Nutrient Sensitivity to Watershed Land **BMP** Nutrient Processes use Land location effect Application Engines calcula use Input change tor Tools Optimization Temporal Static **CAST** Engine watershed Watershed Casttool.org model Model Load to Estuarine model Stakeholder Chesapeake Stakeholder **Products** Calibration **Bay Program** Planning **Planning** Climate change Accounting Lag Times

'Phase 5 Watershed Model'



Lag Times

'Phase 5 CAST'

Data

BMPs

Land cover Nutrient availability Census of Agriculture

Physical characteristics

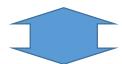
Logic Engines

Land use calcula tor

BMPLand use change

BMPlocation BMPeffect

Nutrient **Application** Sensitivity to **Nutrient Input** Watershed **Processes**



Tools

Temporal watershed model

Static

Watershed Model

CAST

Casttool.org

Optimization Engine



Products

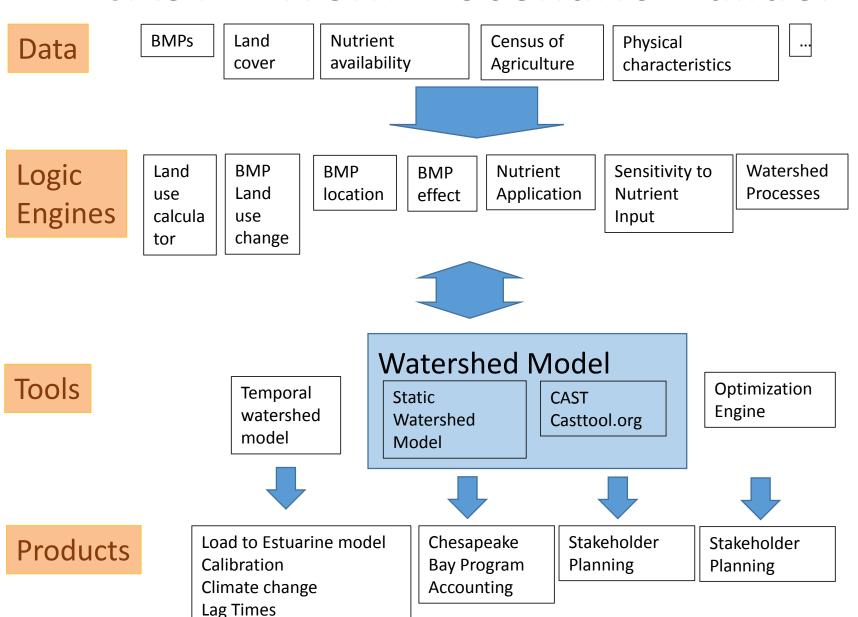
Load to Estuarine model Calibration Climate change Lag Times

Chesapeake **Bay Program** Accounting

Stakeholder **Planning**

Stakeholder **Planning**

CAST = WSM = Scenario Builder













Phase 6 Model Structure

Average Load + \triangle Inputs * Sensitivity **Land Use Acres BMPs** Direct Loads **Land to Water Stream Delivery River Delivery** Phase 6











Section 2:
Average
Loads

Section 3: Inputs

* Section 4: Sensitivity

Section 5: Land Use

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Section 6: BMPs

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Section 7: Land to Water

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Section 9: Stream Delivery

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Section 10: River Delivery

Section 11:
Applications

Section 1:

Overview

Section 8:
Direct Loads











Section 2: Ave Load 27 pages

Section 3: Inputs 48 pages

Section 4: Sensitivity 19 pages

Section 5: Land Use – 12 pages

Section 6: BMPs – 12 pages

Section 7: Land to Water – 22 pages

Section 9: Stream Delivery – 25 pages

Section 10: River Delivery – 88 pages

Section 11: **Applications** 0 pages

Section 1:

Overview

13 pages

Section 8:

Direct Loads - 4 pages

Section 12: References – 33 pages Total = 299 pages + 257 pp appendices

Review Strategy



Review Strategy

- Read Chapter 1
- Target Chapters and Sections that are important to you

- Main Prediction of CAST for decision support: Change in Anthropogenic Load
 - BMPs
 - WWTP
 - Land use Change
 - Response to Change in inputs

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REVIEW

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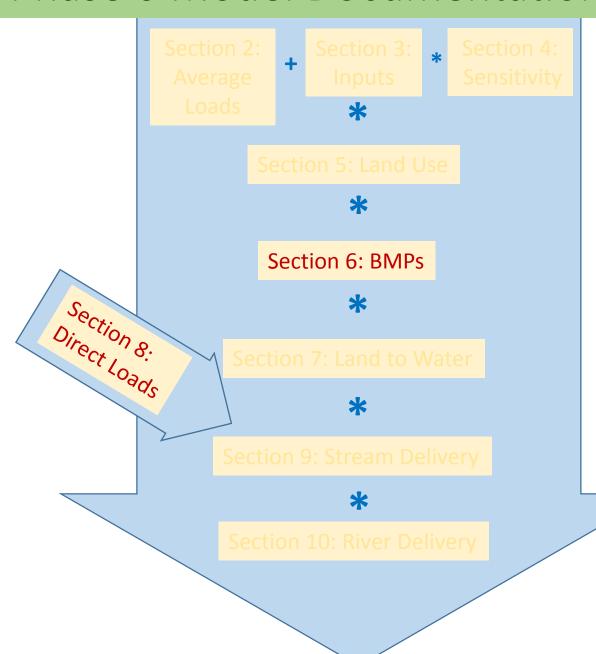
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Review Strategy

- Read Chapter 1
- Target Chapters and Sections that are important to you. – or – talk to someone on the relevant workgroup

- Main Prediction of the Watershed Model for decision support: Change in Anthropogenic Load
 - BMPs
 - WWTP
 - Land use Change
 - Response to Change in inputs

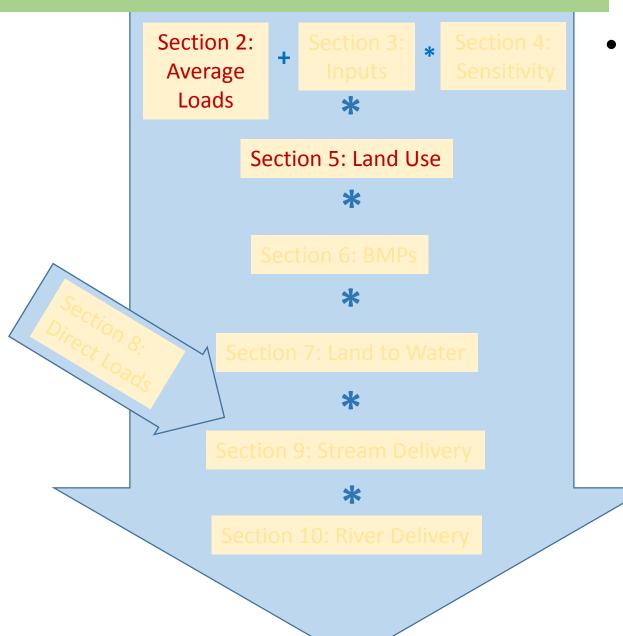


• BMPs

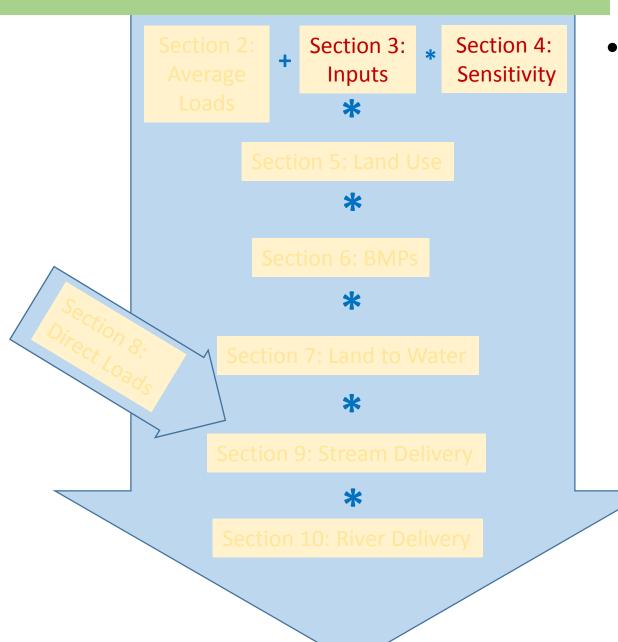
- Section 6 BMPs
- Separate review process for effectiveness
- Can review application method

WWTP

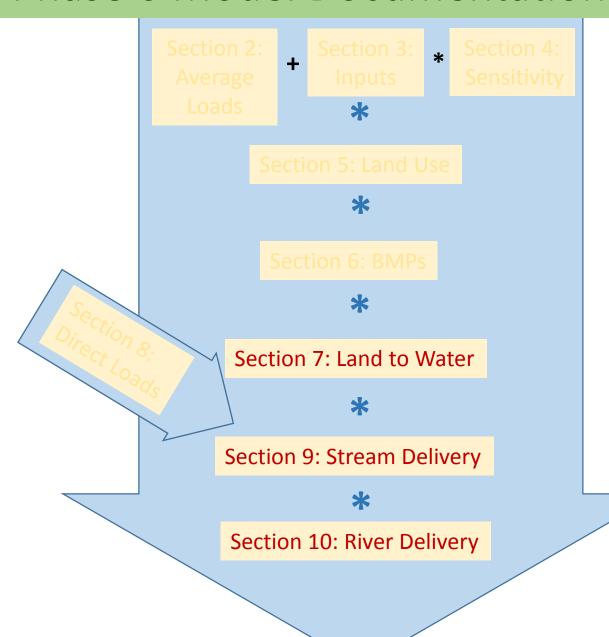
- Section 8 Direct Loads
- Submitted Data



- Land use Change
 - Section 5 Land use
 - Not final
 - Section 2 Average Loads
 - Modeling workgroup
 - WQGIT workgroups



- Response to Change in Input
 - Section 3 Inputs
 - 'scenario builder'
 - WQGIT workgroups
 - Section 4 Sensitivity
 - Modeling workgroup

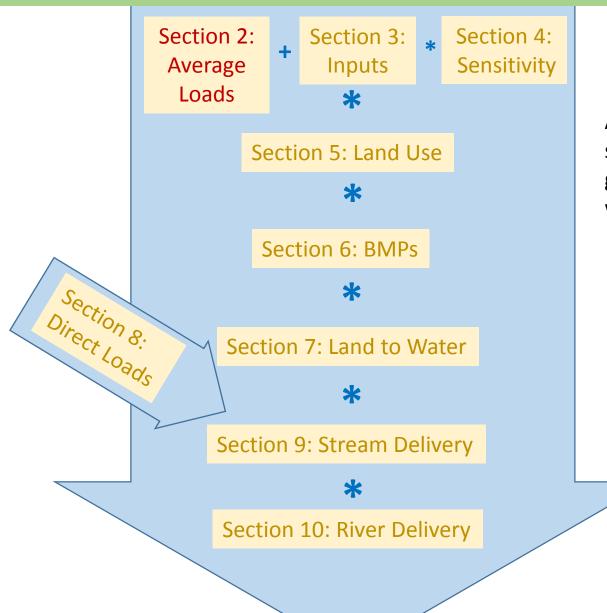


- Watershed Delivery system
 - Spatially distribute loads
 - Check for agreement with monitoring data
 - Modeling workgroup

Beta 2

Major refinements Beta 1 => Beta 2

- Extreme flow events
- Sediment overhaul
- Updated physical watershed data
 - Land to water
 - Stream to river
 - Small reservoirs
 - Groundwater nitrate lag
- Updated input data
 - Point source correction
 - Monitoring data



Average Loads

Average Loads – Average edge-ofsmall-stream loading rate for a given land use for the entire CB watershed



Average Loads

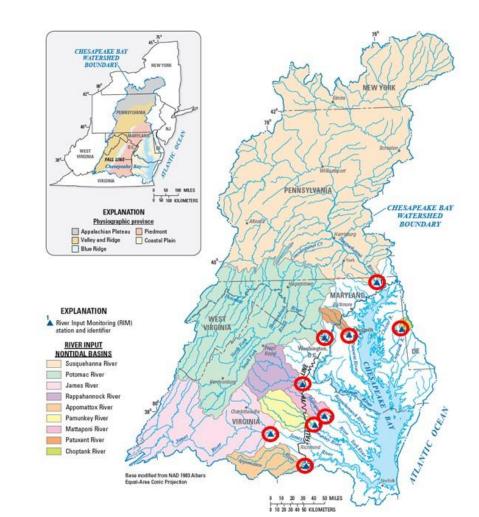
Average Loads – Average edge-of-smallstream loading rate for a given land use for the entire CB watershed



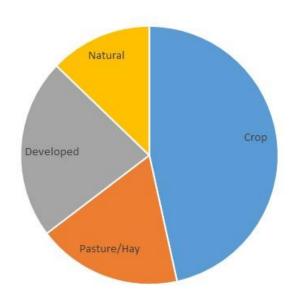
Estimate Total Non-point Source

Modeling Workgroup

Monitoring Data
subtract point source
divide by river transport



Average Loads



Average Loads – Average edge-of-smallstream loading rate for a given land use for the entire CB watershed

Divide into Broad Classes

Modeling Workgroup

Multiple models

Phase 5.3.2

Sparrow

CEAP

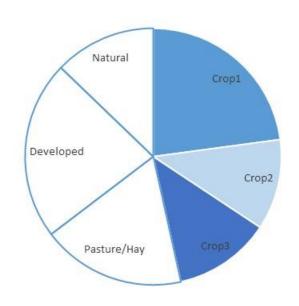
Divide into broad classes -- Nitrogen

Sector	Crop	Pasture/ Hay	Developed	Natural
Acres*	4,361,964	5,156,450	5,289,606	24,788,695
P532 Export Rate (pounds per acre)	47.5	19.9	19.4	4.2
CEAP Export Rate (pounds per acre)	42.5	10.2	Not used	1.6
SPARROW Export Rate with BMP effects removed (pounds per acre)	22.9	10.2	8.9	0.4
Average Ratio to Crop Rate	1.00	0.37	0.40	0.05
Average Sector Export Rate (pounds per acre)	46.65	15.36†	18.62	2.26

^{*} Note that no target is calculated for 1,148,100 acres in the land uses: permitted feeding space, non-permitted feeding space, and combined sanitary sewer and water.

[†] The afo/cfo load of 9,063,059 pounds is removed from pasture.

Average Loads



Average Loads – Average edge-of-smallstream loading rate for a given land use for the entire CB watershed

Split Classes into individual land uses

WQGIT Workgroups

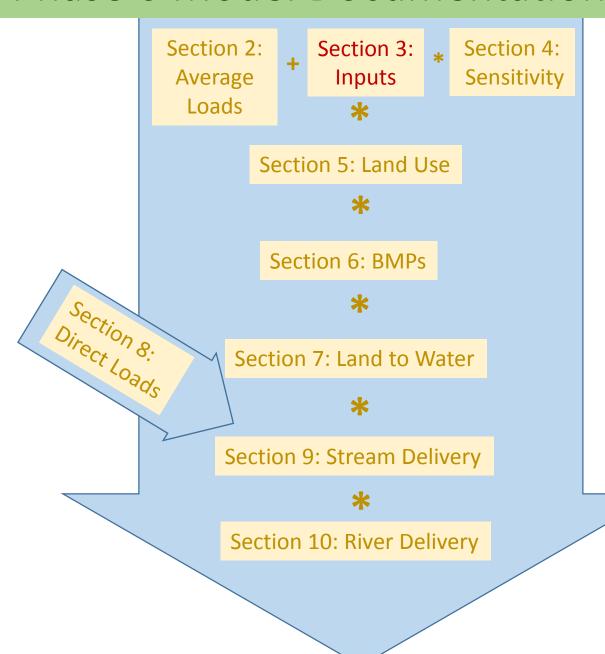
Multiple lines of evidence to develop ratios

- for example silage is 16% higher than grain

Split classes into individual land uses – Crop Nitrogen

Target Sector	Land Use	Acres	TN Export Rate Ratio	TN Export Rate (pounds per acre per year)
Cropland	Full Season Soybeans	926,048	0.71	36.98
	Grain with Manure	362,887	1.40	72.93
	Grain without Manure	989,101	1.00	52.09
	Other Agronomic Crops	527,481	0.45	23.44
	Silage with Manure	188,744	1.62	84.39
	Silage without Manure	403,534	1.16	60.42
	Small Grains and Grains	420,426	0.84	43.76
	Small Grains and Soybeans	313,019	0.79	41.15
	Specialty Crop High	66,706	1.34	69.8
	Specialty Crop Low	164,013	0.31	16.15

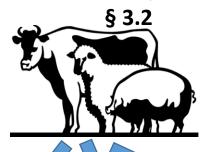
Phase 6 Model Documentation



- Inputs
 - Manure
 - Inorganic fertilizer
 - Legume fixation
 - Uptake
 - Atmospheric deposition
 - Crop cover
 - Plowing effects

Phase 6 Inputs Conceptual Model

Livestock Manure (and Biosolids)



Barnyard § 3.2.2 and § 3.2.3



Fertilizer § 3.3



Nutrient Application Prescription § 3.2.7 and § 3.3.3



Pasture

Access Area § 3.2.2



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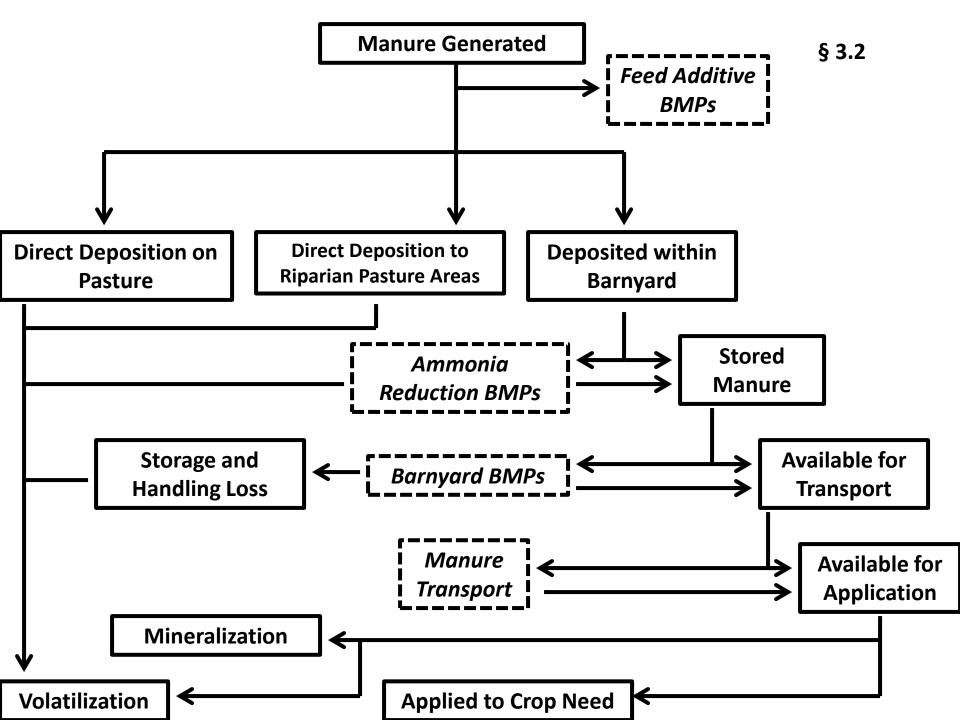
Crops



River

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Manure: Estimating Manure Generation § 3.2.1

Animal Type	Manure Source	Lbs Dry Manure/Animal/Yr	Lbs TN/Lb Dry Manure	LbsTP/Lb Dry Manure
Beef	Use Beef - Cow (confinement) from ASAE 2005 for manure values	5,475.00	0.028788	0.006467
Dairy	Use Lactating Cow, Dry Cow and Heifer from ASAE 2005 for manure values	4,404.33	0.042221	0.006764
Other Cattle	Use average of Beef and Dairy from above to estimate manure values	4,939.67	0.035504	0.006616
Horses	Use average of Horse- Sedentary and Horse - Intense Exercise from ASAE 2005 for manure values	3,102.50	0.031672	0.005941
Hogs for Breeding	Use Gestating Sow and Lactating Sow ASAE 2005 for manure values	657	0.070273	0.019417
Hogs for Slaughter	Use Grow-Finish from ASAE 2005 for manure values	120	0.083333	0.014167
Sheep and Lambs	Use ASAE 2003 for manure values	240.9	0.038182	0.007909
Goats	Use ASAE 2003 for manure values	680.91	0.034615	0.008462

[•]Poultry litter estimates vary by year and are explained in detail in the PLS report.

Manure: Separating Manure into Piles § 3.2.2

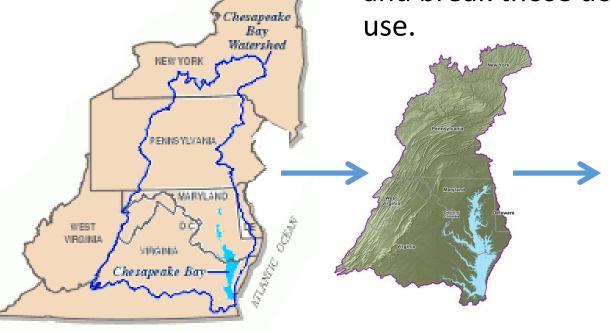
- States were asked to estimate how much time each animal type would spend in the barnyard, in pasture and in the access area.
- These percentages separate the generated manure.

Growth Region	Animal Type	Month	Barnyard %	Pasture %	Access Area %
WV_1	beef	1	6	91	3
WV_1	beef	2	6	91	3
WV_1	beef	3	0	96	4
WV_1	beef	4	0	94	6
WV_1	beef	5	0	94	6
WV_1	beef	6	0	90	10
WV_1	beef	7	0	90	10
WV_1	beef	8	0	90	10
WV_1	beef	9	0	94	6
WV_1	beef	10	0	96	4
WV_1	beef	11	0	96	4
WV_1	beef	12	6	91	3

Inorganic: Going from Sales to Use

§ 3.3.1 Be the

 Begin with regional-level sales, break those down to watershed-level sales, and break those down to county-level use.



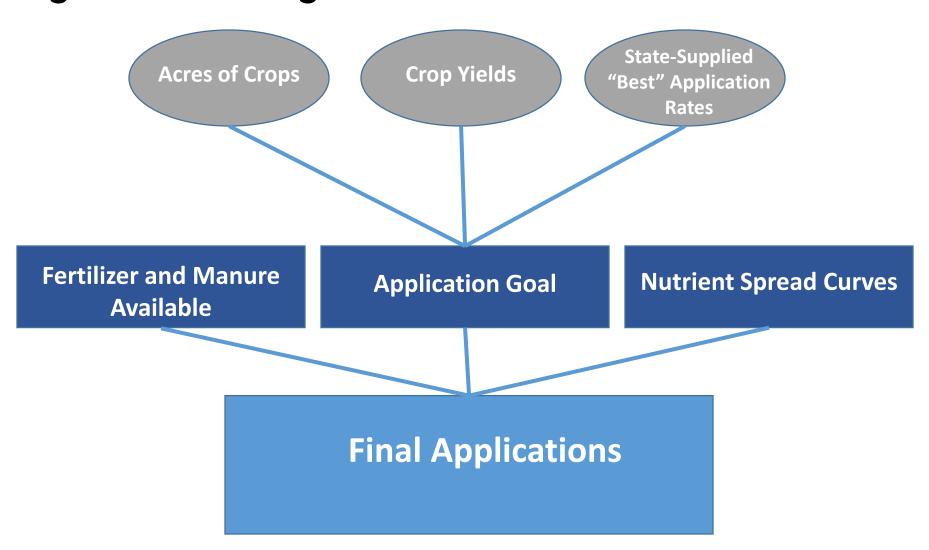
•Sum AAPFCO sales across 6 states, and estimate sales used by farms.

•Calculate dollars spent on fertilizer from Ag Census in counties inside and outside watershed to "clip" watershed-only sales. •Calculate fertilizer need by county as a combination of fractional dollars spent on fertilizer and fertilizer need after manure is applied. Use value to distribute fertilizer to each county.

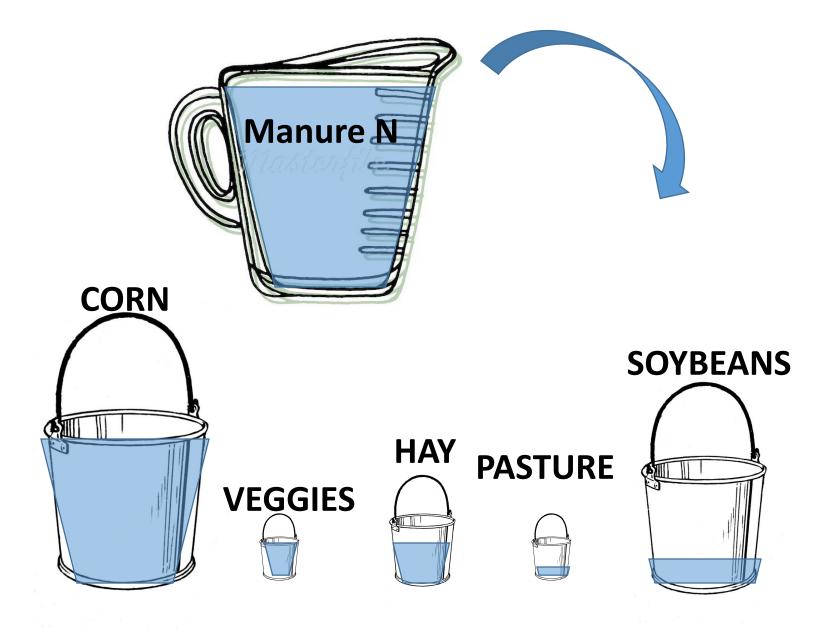
Example of Fertilizer Distribution Method for Nitrogen in 2012

- •Regional Farm Sales = 603,579,944 lbs N or
 - •(Sum of lbs N sold across 6 states) X (3-year rolling average fraction of Farm Sales)
- •Watershed-Wide Farm Sales = 413,741,002 lbs N or
 - •(Regional Farm Sales)X (Fraction of Ag Census Expenditures on Fertilizer and Soil Amendments that occurred within the Watershed)
- •Fertilizer Available for Hypothetical County = 8,274,820 lbs N or
 - •(Watershed-Wide Farm Sales) X [(Fraction of Ag Census Expenditures on Fertilizer within County X 0.5)+(Fraction of Fertilizer Need within County X 0.5)]

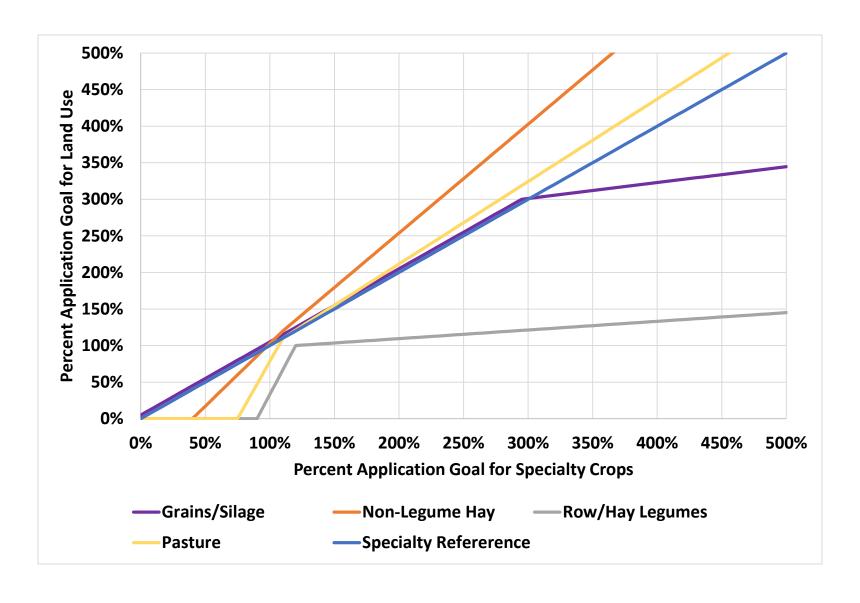
"Prescribing" Applications to Crops § 3.2.7 and § 3.3.3



Filling the Buckets of Application Goal



Manure: Prioritizing Manure Nitrogen Applications (and Biosolids) § 3.2.8



Revisions for Beta 2 (April)

- Improvements for April calibration include:
 - Inorganic fertilizer distributed to crops only after all BMPs are simulated.
 - Manure mineralization rates, which impact the amount of manure nutrients available to crops, updated to reflect typical nutrient management mineralization rates by decade.
 - Manure recoverability, or the amount of manure generated in a barnyard that can be made available to crops, before and after the implementation of Animal Waste Management Systems was updated to reflect estimates provided in http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs14 3_012131.pdf.
 - Acres of barnyards or feeding facilities were updated to reflect the Bay Program's best estimates per animal type.
 - Nutrient application goals for the minor crops, emmer, spelt and triticale, were based upon state-recommended applications on a per acre basis as very little yield data was available to vary the application goals by annual yield
 - New BMP information submitted by some states.
 - New biosolids data submitted by DE.

Revisions for Beta 3 (July)

Crop Application Goals

 Group of Agricultural Workgroup state representatives worked with the AMS to revise crop application goals so they better reflect land-grant university recommendations.

Non-Nutrient Management Application Goal Multiplier

 Subgroup of Nutrient Management expert panel supplied revised multipliers for Crop Application Goals.

Legume Fixation

 AMS approved use of new equation to estimate legume fixation based upon estimates of nitrogen from soils, manure and inorganic fertilizer.

Crop Removal

 AMS reviewed existing crop removal/uptake values, and agreed to adjust values for corn, beans, pasture and non-legume hay.

Barnyard Area for Other Cattle

Area adjusted so it better reflects NRCS estimates of area used by cattle.

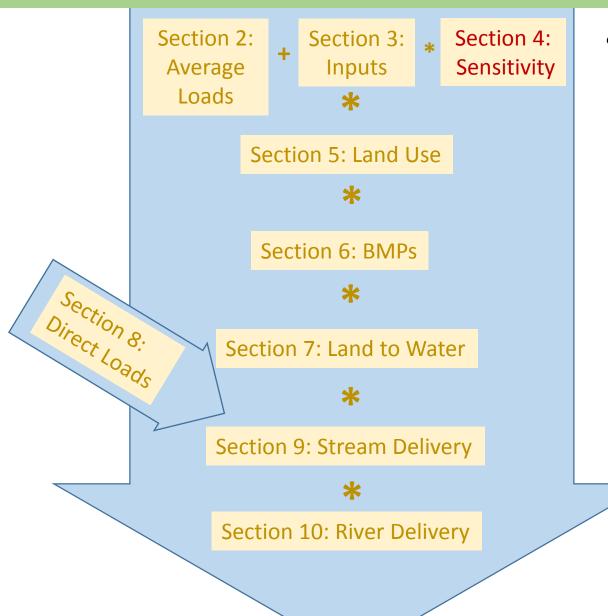
Biosolids

 Ag Workgroup and Wastewater Technical Workgroup approved use of new curves to spread biosolids to crops.

Atmospheric Deposition

- Currently using phase 5.3.2
- Expecting Data set from Penn State for Beta 4
- Data set will be modified by scenarios in CMAQ

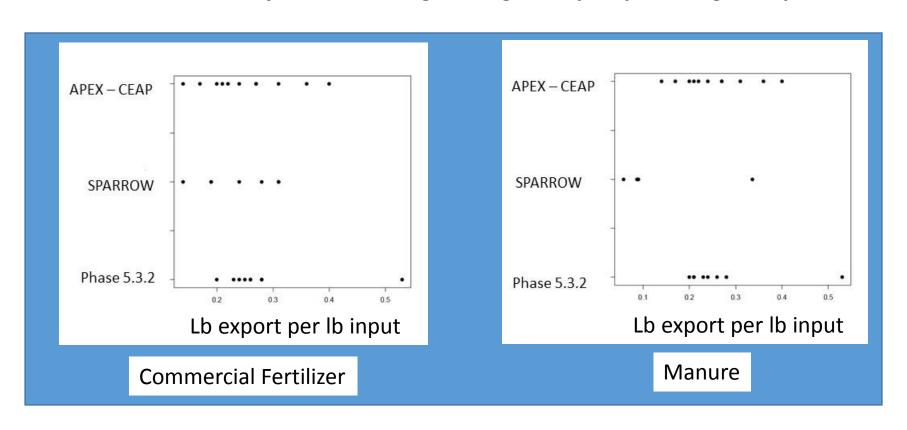
Phase 6 Model Documentation



- Sensitivity
 - Change in output per change in input

Nitrogen Sensitivity

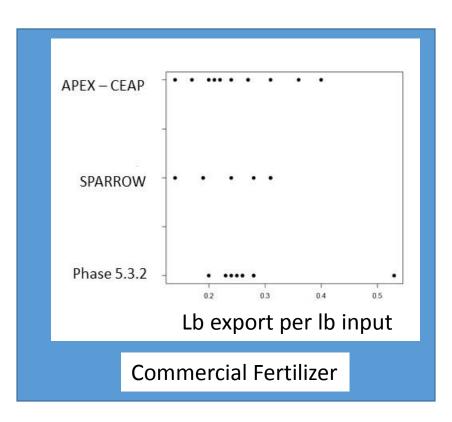
Definition – Average Change in export per change in input



Multiple Model comparison – All in general agreement on the average effect

Nitrogen Sensitivity

Definition – Average Change in export per change in input



Modeling Workgroup Decision: Use Phase 5.3.2 for global sensitivities

- Supported by CEAP and SPARROW results
- Answers the right question
 - *Change* in export per *change* in input
- No direct access to APEX-CEAP
- Sparrow had different land use classifications

Sensitivity of Phase 5 Hightill with Manure land use

	NH3	NO3	ORGN
Atmospheric			
Deposition	0.01	0.226	0.083
Fertilizer	0.018	0.19	0.073
Manure	0.005	0.067	0.104
Fixation	0.01	0.19	0.101
Crop Uptake	0	-0.057	0
Vegetative Cover	-0.012	0.012	-0.404

Beta 2

Sensitivities are modified according to relative loading rates

P5.3.2 hwm = p6 gwm (grain with manure)

What about other land uses?

Adjust by load ratio => Small Grains is 60% of Grain with manure load

Adjusted sgg sensitivity = gwm sensitivity * 60%

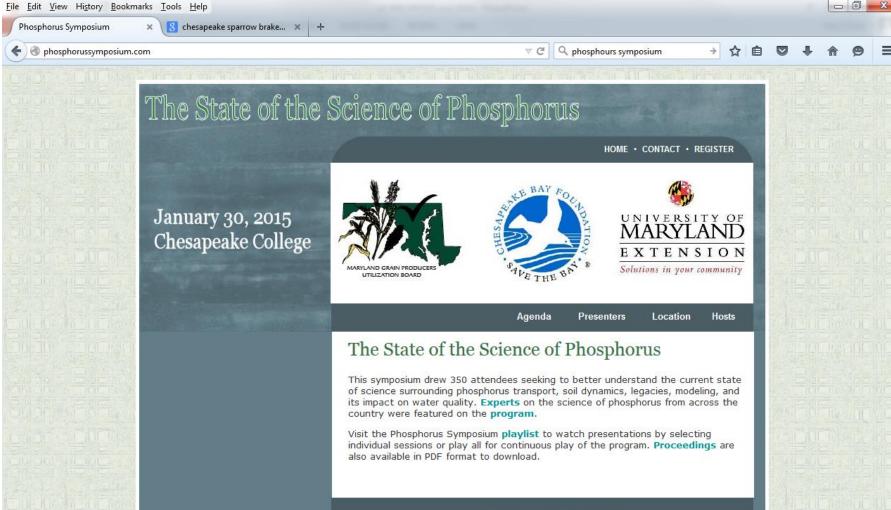
STAC Guidance on Phosphorus

A Review of Agricultural P-dynamics in the Chesapeake Bay Watershed Model



"...output from CBWM [indicated] major reductions in P losses from cropland on the Maryland Eastern Shore that seemed to be inconsistent with research findings and monitoring data in the region."





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Phosphorus Conceptual Model

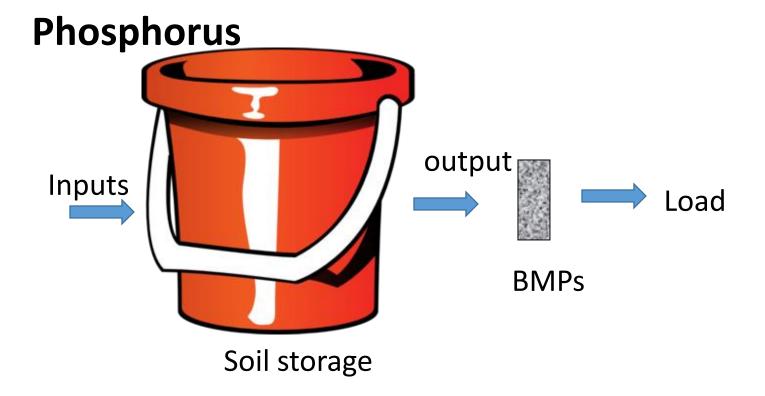
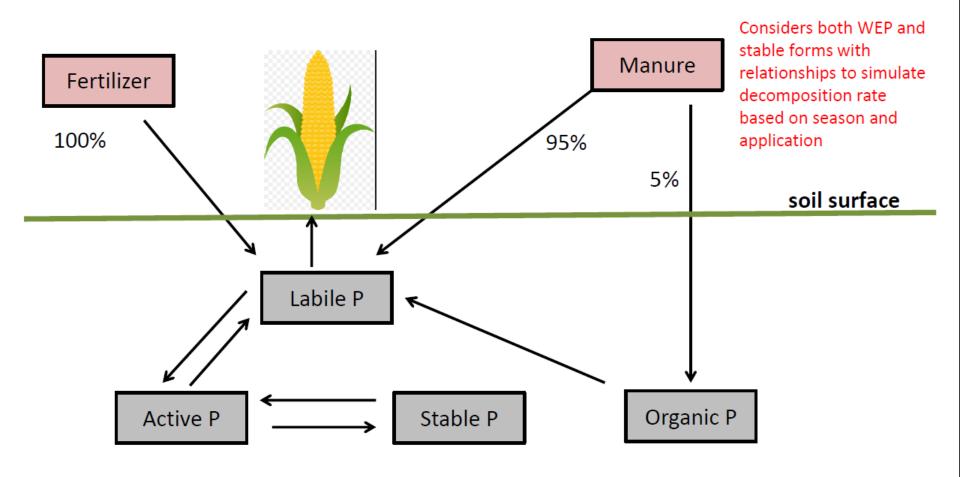


Diagram of APLE Nutrient Sources and Soil Pools

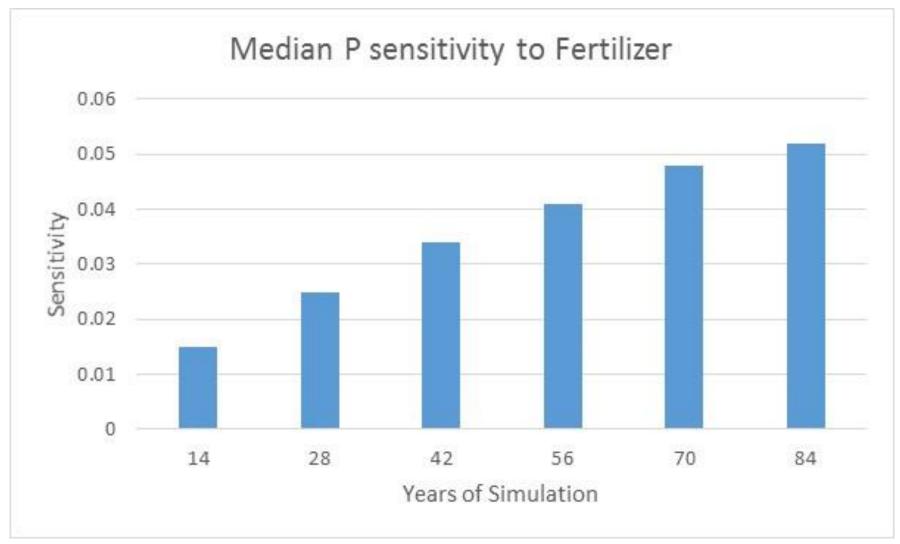


Equations to estimate Manure runoff P, Fertilizer runoff P, Sediment P loss, and Dissolved Soil P runoff



The concept of a sensitivity to inputs is problematic because the long term simulations do not level off

Different Simulation Periods to Evaluate Sensitivities



APLE Hightill Landuse Sensitivities using Constant Mehlich 3 Soil P

Table 1. Phosphorus Loss APLE Model Sensitivity to change in inputs						
Inputs	Units	MEDIAN SLOPE	MEDIAN SR	Relative Sensitivity		
Mehlich	ppm	0.015	0.696	Sensitive		
Sediment	ton/ac	0.168	0.633	Sensitive		
Runoff	inches	0.057	0.403	Moderately sensitive		
Manure	lbs/acre	0.007	0.111	Slightly sensitive		
Fertilizer	lbs/acre	0.004	0.068	Slightly sensitive		
Uptake	lbs/acre	0	0	Insensitive		

APLE Hightill Landuse Sensitivities using Constant Mehlich 3 Soil P

	Table 1. Phosphorus Loss APLE Model Sensitivity to change in inputs						
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	Fertilizer	ibs/acre	0.004	0.068	Slightly sensitive		
	U ptake	lbs/acre	0	0	Insensitive		

Requires estimate of soil P

Summary of Soil P data sources

SOURCE	YEARS	LOCATION	UNITS	SAMPLE TYPE
				by county &
AgriAnalysis	2003 - 2014	DE,MD,NY,PA,VA,WV	Phos lbs/ac	zip code
Penn State University	2001 - 2014	PA	Mehlich III soil P (ppm)	by county and by crop
V				
Virginia Tech Soil Testing Lab	Average of 2012-2014	VA	Mehlich III soil P (ppm)	by county and by crop
University of Maryland	1954 - 2002	MD	number of samples	by county
University of Maryland	1992	DE,MD,NY,PA,VA,WV	Mehlich III soil P (ppm)	by county

Soil P Landuse Ratios

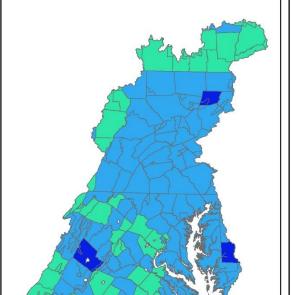
Landuse Landuse name		PA		VA	
		Average Mehlich III	Ratio	Average Mehlich III	Ratio
ALL	ALL	102		85	
sch	Specialty Crop High	190	1.9	146	1.7
scl	Specialty Crop Low	151	1.5	120	1.4
oac	Other Agronomic Crops		1.3 0.9		_
swm	Silage with Manure Grain with Manure	90 89	0.9		_
gwm		83	0.9		
soy	Full Season Soybeans	65	0.8	04	0.8
sgg	Small Grains and Grains	76	0.7	72	0.8
ohy	Other Hay	73	0.7	58	0.7
lhy	Legume Hay	73	0.7	58	0.7
pas	Pasture	66	0.6	56	0.7

- PA and VA provided soil P data by crop.
- The average soil P ratios were applied to other states' soil P datasets.

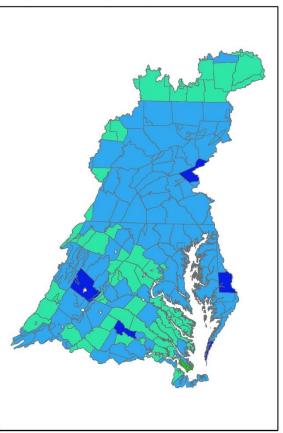
Legend

Mehlich III Soil P (ppm) Low (0 - 20) Medium (21 - 46) High (47 - 127) very High (> 127)

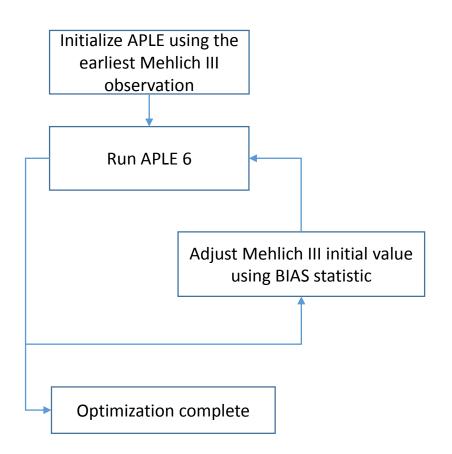
Small Grains and Grains (sgg) Other Hay (ohy)



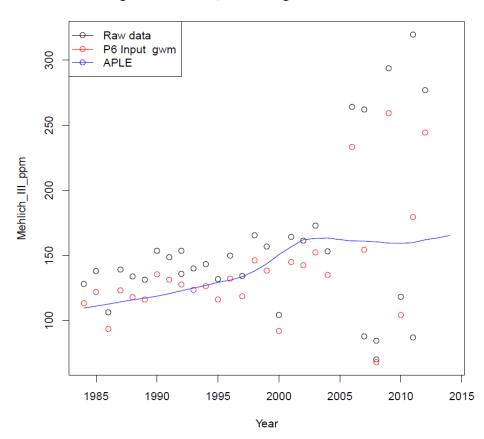
Legume Hay (lhy)



Soil P History



Segment N24011, landuse gwm & bias = 1.78e-06

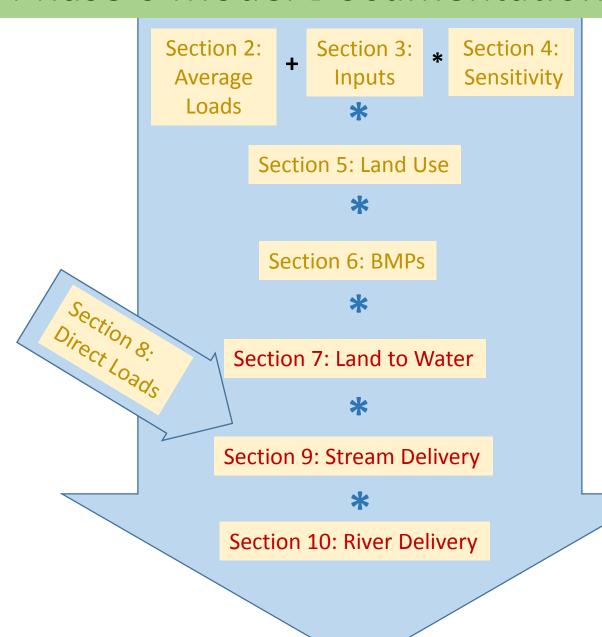


Review Strategy

- Read Chapter 1
- Target Chapters and Sections that are important to you

- Main Prediction of CAST for decision support: Change in Anthropogenic Load
 - BMPs
 - WWTP
 - Land use Change
 - Response to Change in inputs

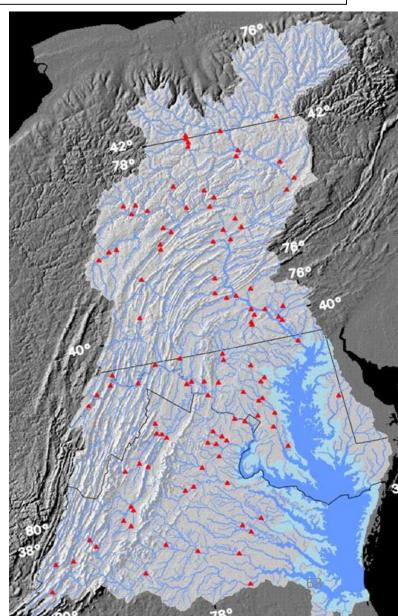
Phase 6 Model Documentation



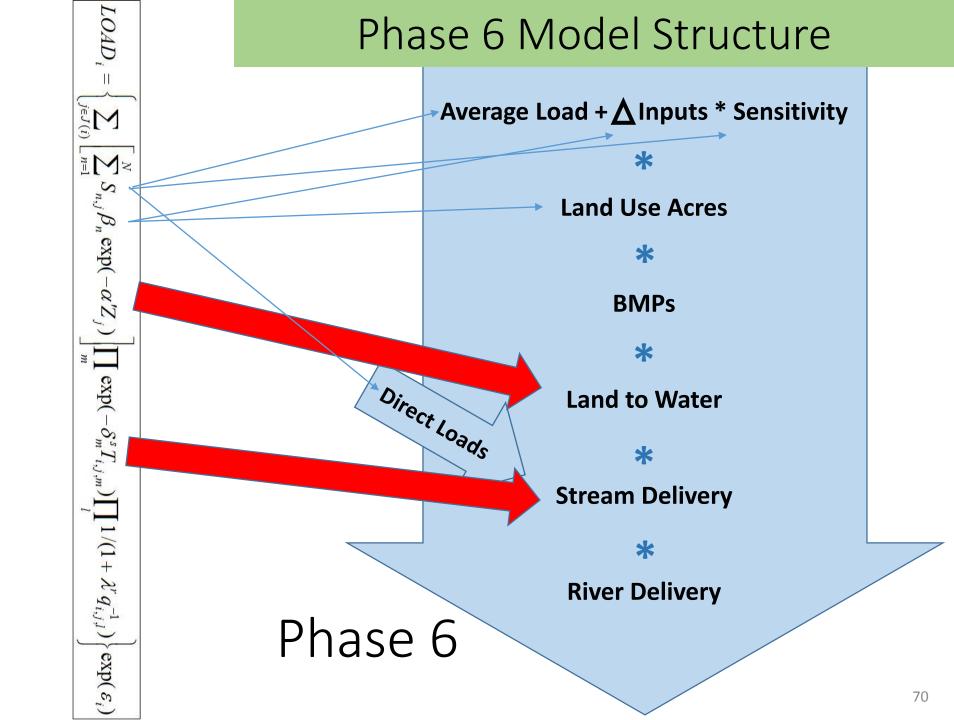
- Watershed Delivery system
 - Spatially distribute loads
 - Check for agreement with monitoring data
 - Modeling workgroup

USGS Sparrow Model

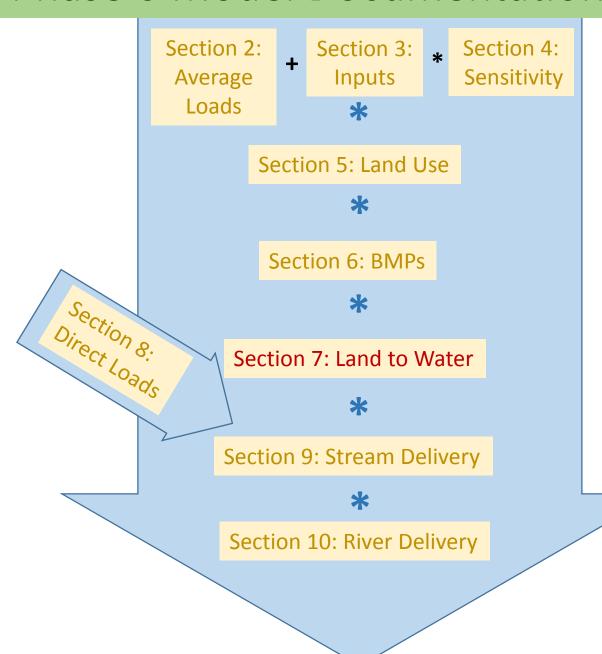
- Regression Model
- Gain knowledge about the watershed based on observations



Phase 6 Model Structure Average Load + \triangle Inputs * Sensitivity $S_{n,j}\beta_n \exp(-\alpha'Z_j) \left| \prod_m \exp(-\delta_m^s T_{i,j,m}) \prod_l 1/(1+\lambda' q_{i,j,l}^{-1}) \right| \exp(\varepsilon_i)$ **Land Use Acres** * **BMPs** * Direct Loads **Land to Water Stream Delivery River Delivery** Phase 6 69



Phase 6 Model Documentation



- Land to Water
 - Loads are already edge-of-stream but based on large averages
 - L2W factors spatially distribute the loads based on watershed characteristics
 - L2W factors have no net effect on the overall loads

Catchment and Reach Attributes Used in SPARROW Models

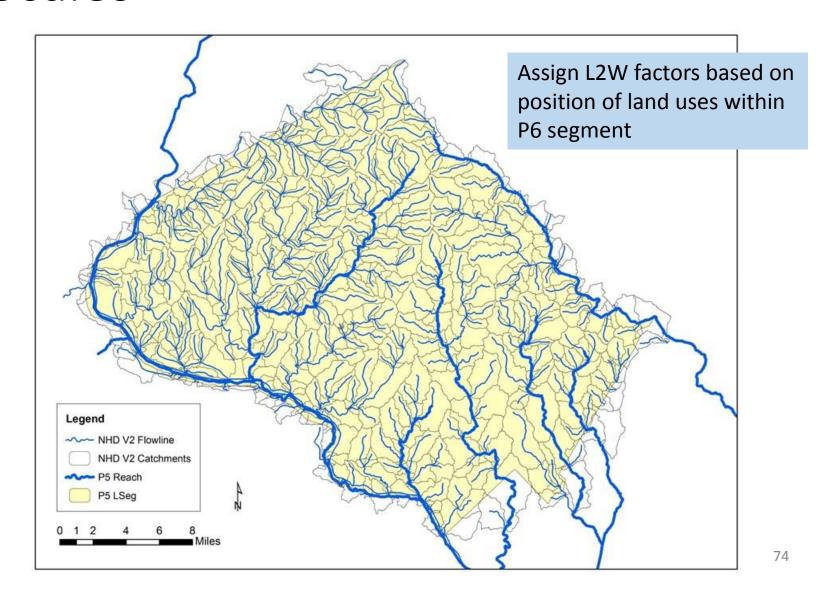
Explanatory Variable	Nitrogen	Phosphorus
Land-to-Water Delivery	 % catchment in Piedmont carbonate Groundwater discharge Available soil water capacity 	 % catchment in Coastal Plain Precipitation * Soil erodibility * well-drained soils
	4. Enhanced vegetative index	

Catchment and Reach Attributes Used in SPARROW Models

Explanatory Variable	Nitrogen	Phosphorus
Land-to-Water Delivery	 % catchment in Piedmont carbonate Groundwater discharge Available soil water capacity Enhanced vegetative index 	 % catchment in Coastal Plain Precipitation * Soil erodibility * well-drained soils

^{*} Not used in Beta 2 calculations because redundant with APLE sensitivities to runoff and erosion

Comparison of NHD+ and P6 Scales

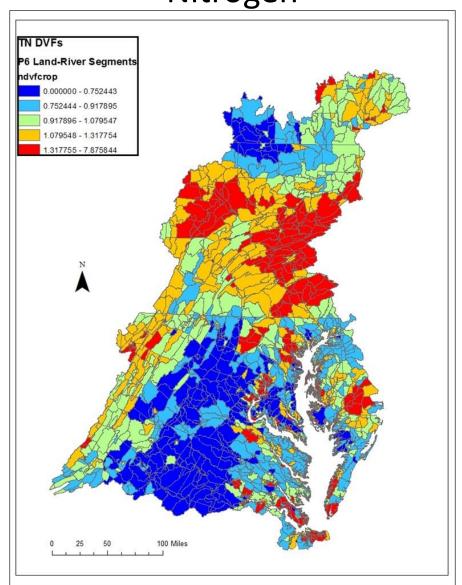


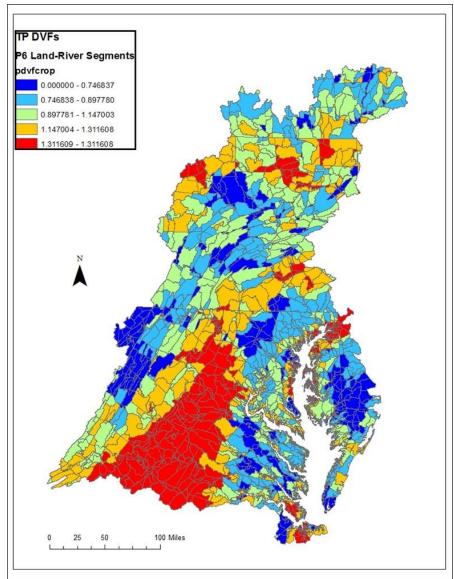
Crop L2W Factors



Nitrogen





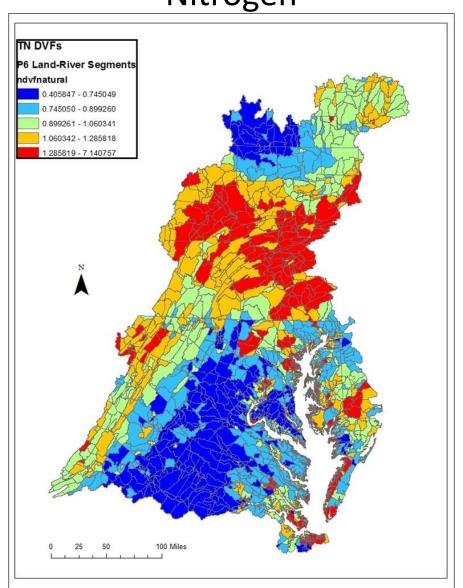


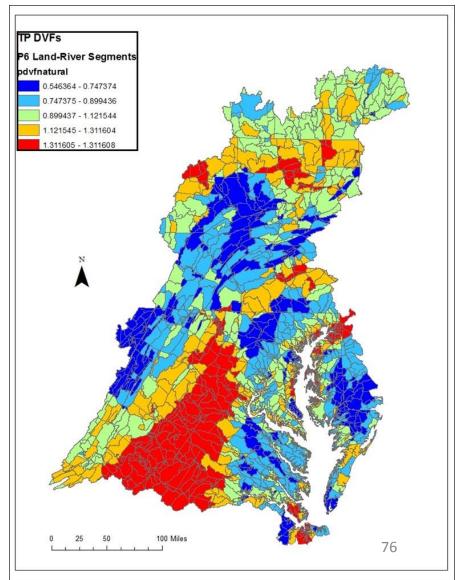
Natural L2W Factors Beta 2



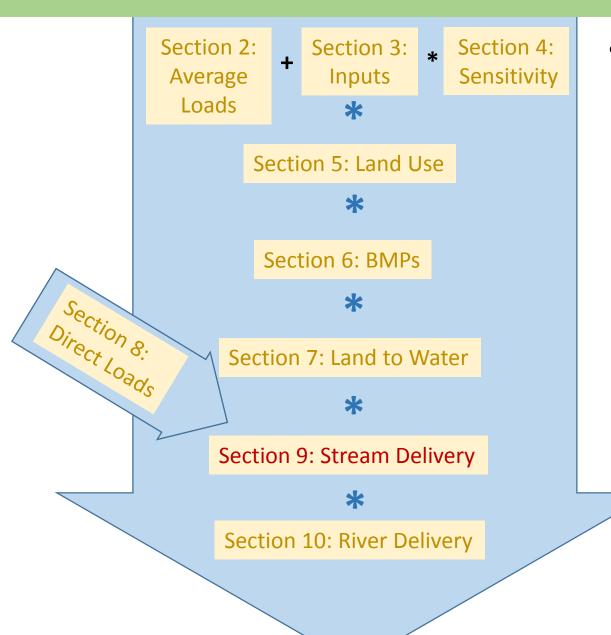
Nitrogen







Phase 6 Model Documentation

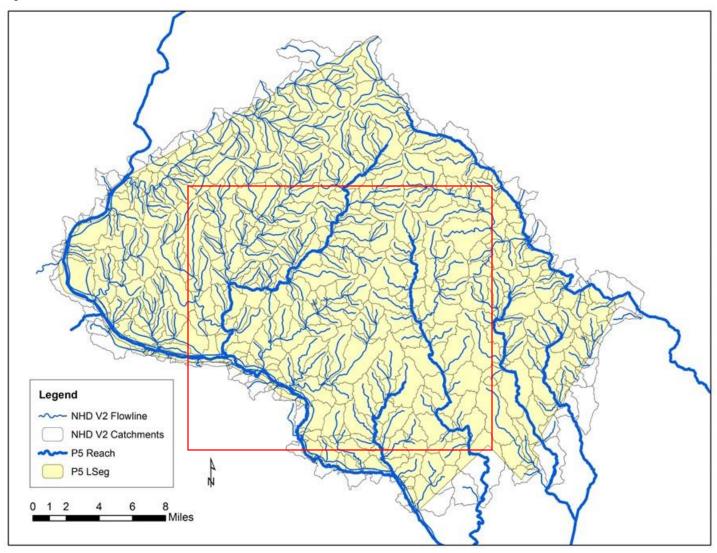


- Stream Delivery
 - The effect of small streams
 - Roughly 1st 3rd order
 - Smaller than a river segment
 - Not simulated with HSPF

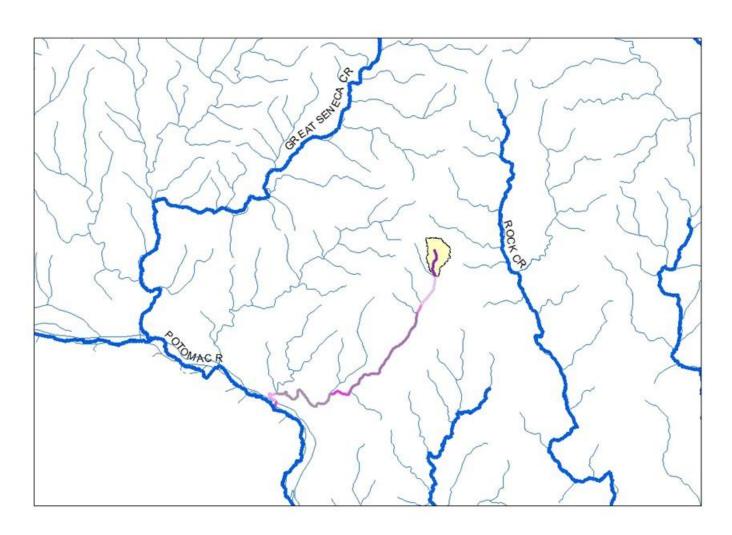
Catchment and Reach Attributes Used in SPARROW Models

Explanatory Variable	Nitrogen	Phosphorus
Stream-to-River Factors (Aquatic Decay)	Impoundments: Hydraulic loading rate	Impoundments: Hydraulic loading rate
	Rivers and streams: Average annual temperature Travel time	Rivers and streams: No losses represented

Comparison of NHD+ and P6 Scales

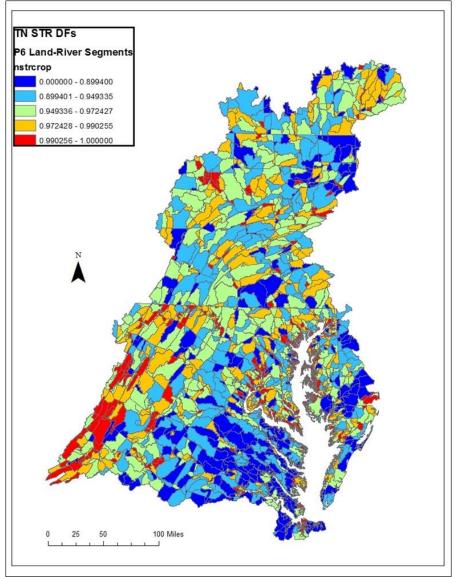


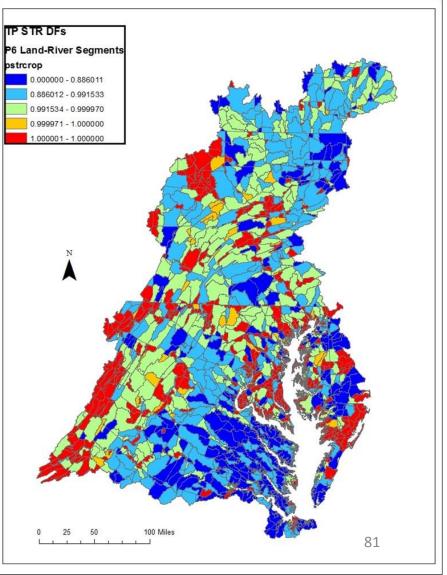
Transport Path from NHD+ Catchment to P6 River Reach



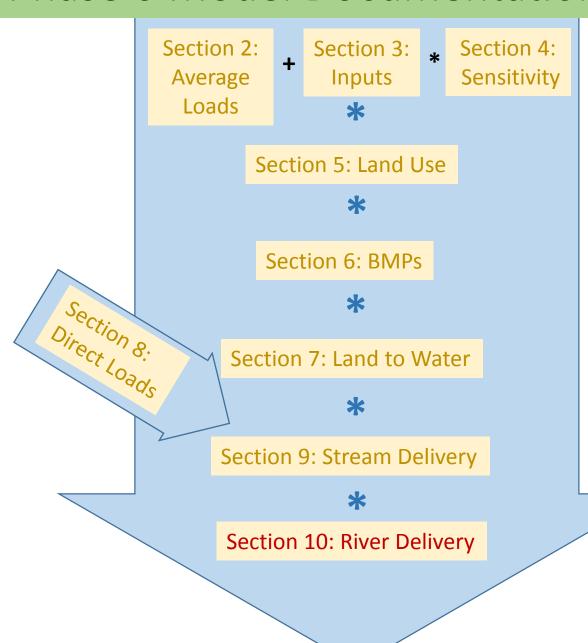
Stream-to-River Delivery Factors

NitrogenPhosphorus



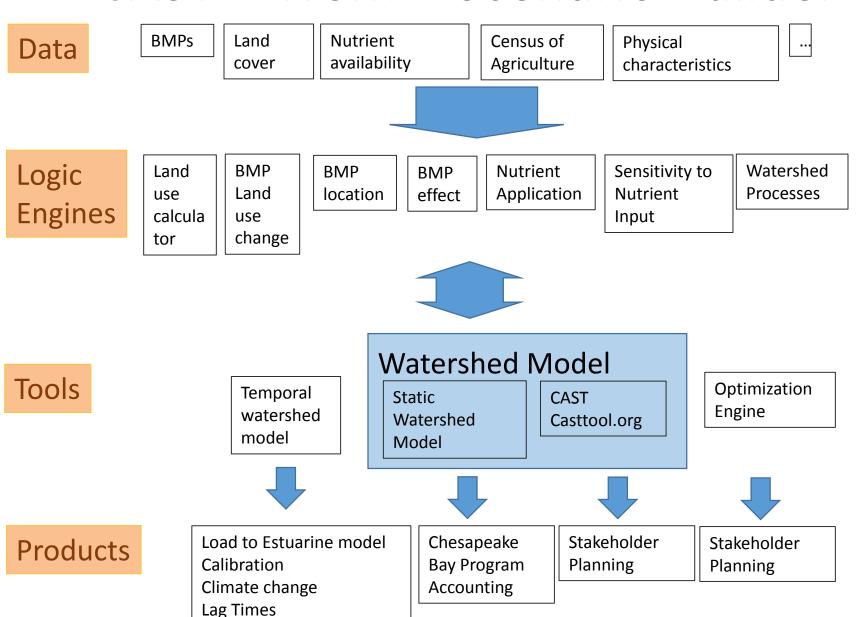


Phase 6 Model Documentation



- River Delivery
 - The effect of large rivers
 - Each river segment has exactly one large river
 - except for some coastal plain segments with no river
 - Simulated with HSPF

CAST = WSM = Scenario Builder



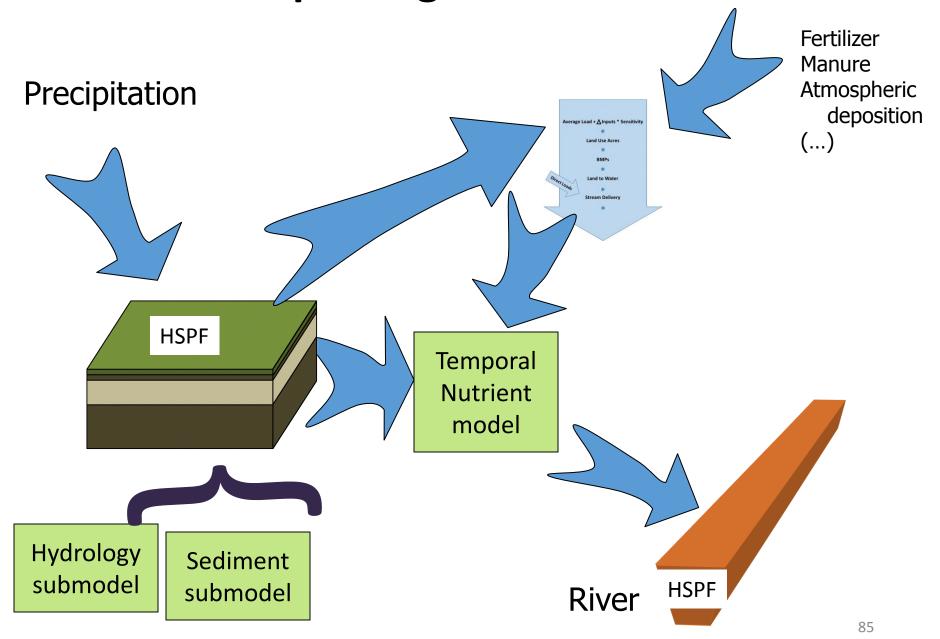
CAST = WSM = Scenario Builder

Temporal model uses

- Calibrate the watershed model to observations
 - Make sure the entire system matches observations
- Supply parameters to the simulation of nutrients
 - Flow and sediment are needed as inputs for the sensitivity calculation
- Create Input loads for the estuarine model
 - Need temporal and spatial loads
- Investigate emergent watershed response
 - Climate change
 - Lag times
- **Proc** Estimate delivery factors for simulated rivers
 - The last box in the 'simple p6 model'

Tool

Model to compare against Observations

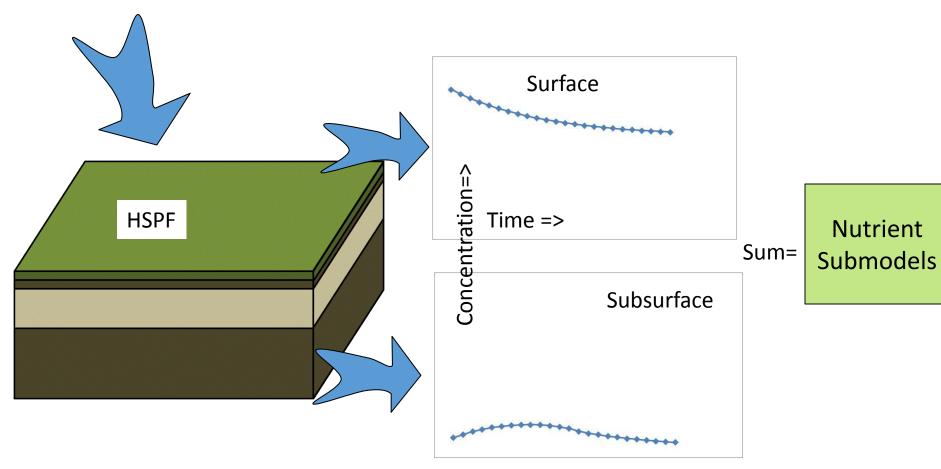


Lag Models - Nitrogen

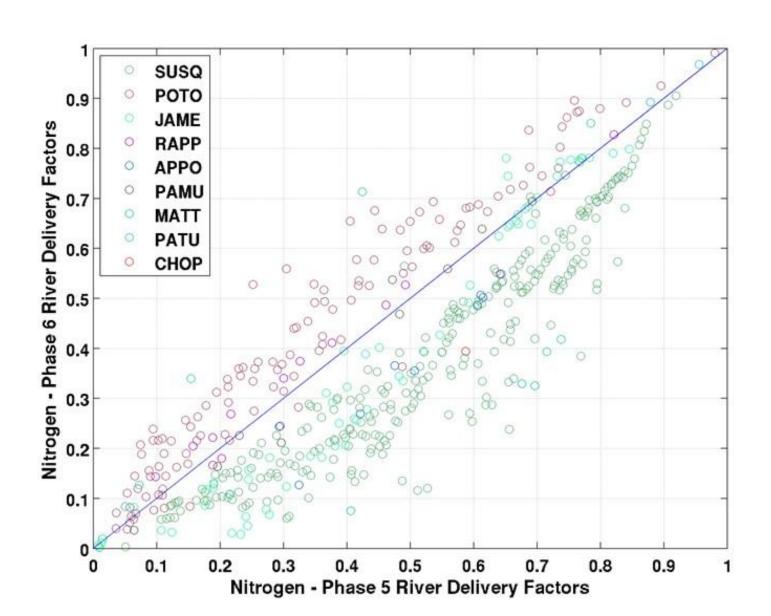
Each Loading Event Surface Concentration=> **HSPF** Time => **Nutrient** Sum= Submodels Subsurface

Lag Models - Phosphorus

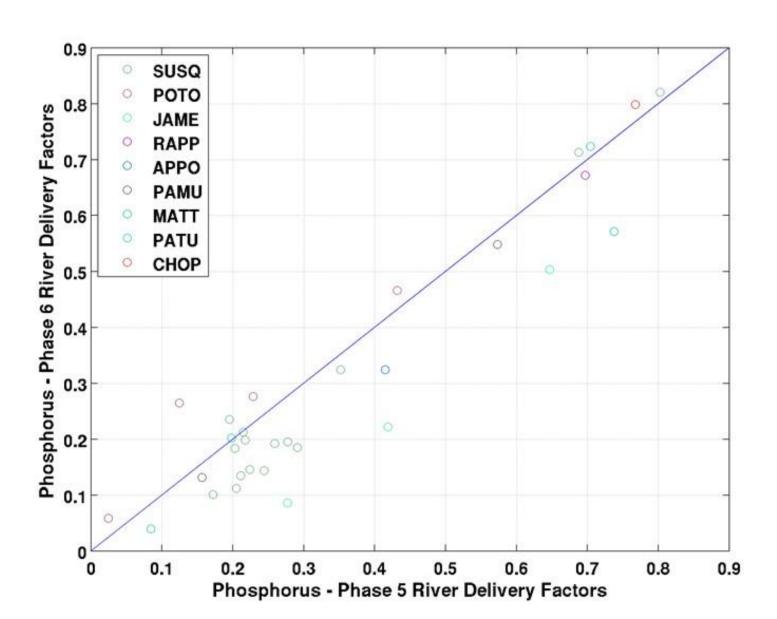
Each Loading Event



Nitrogen delivery factors



Phosphorus delivery factors



Moment of Truth

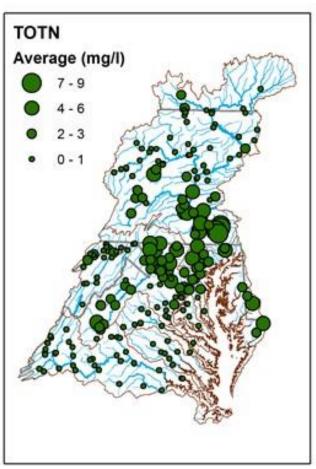
- Phase 5 Complex process model
- Phase 6 Simple models built of consensus decisions

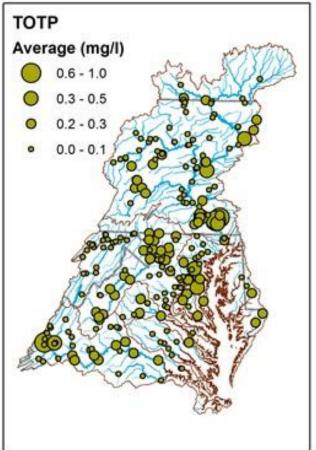
... but does it work?

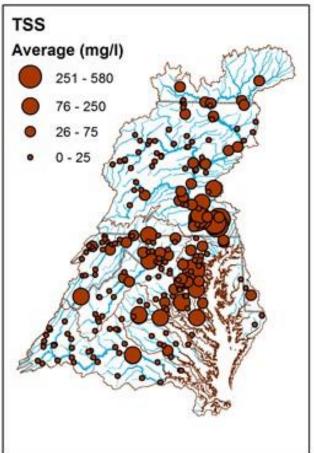
Compare

Heavily-Calibrated Phase 5.3.2 Lightly-Calibrated Phase 6

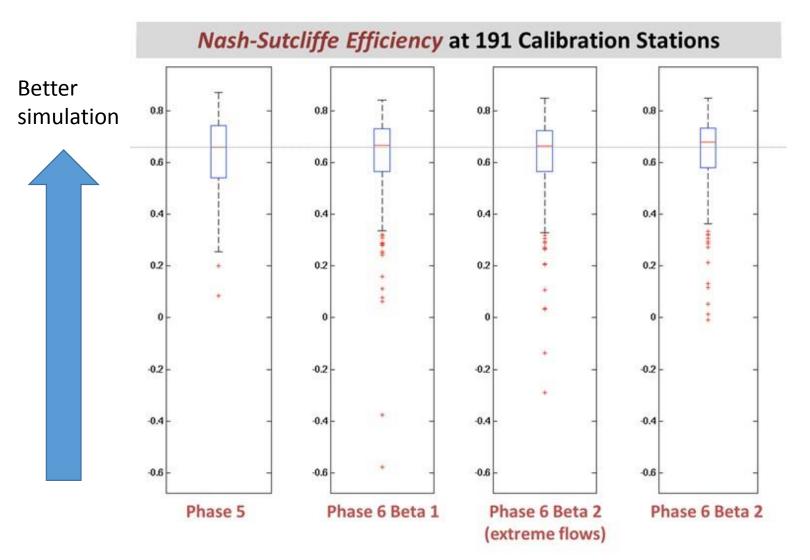
Monitoring Stations



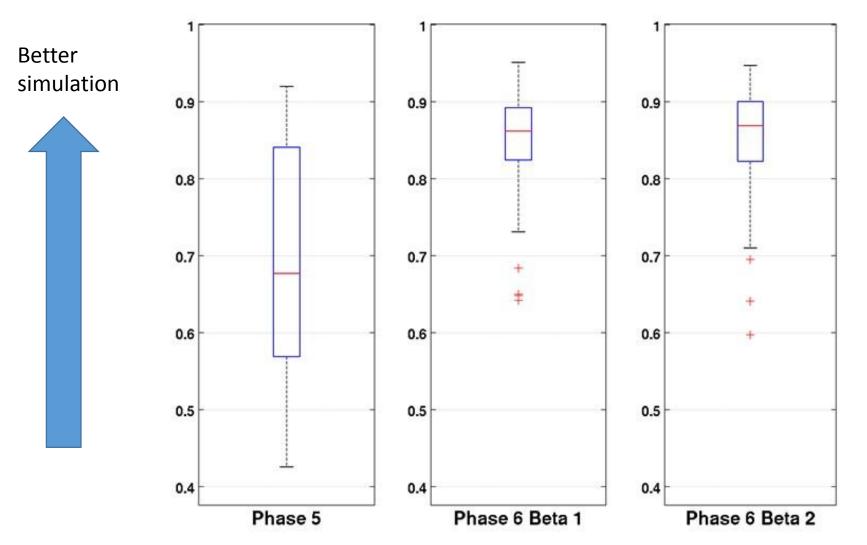




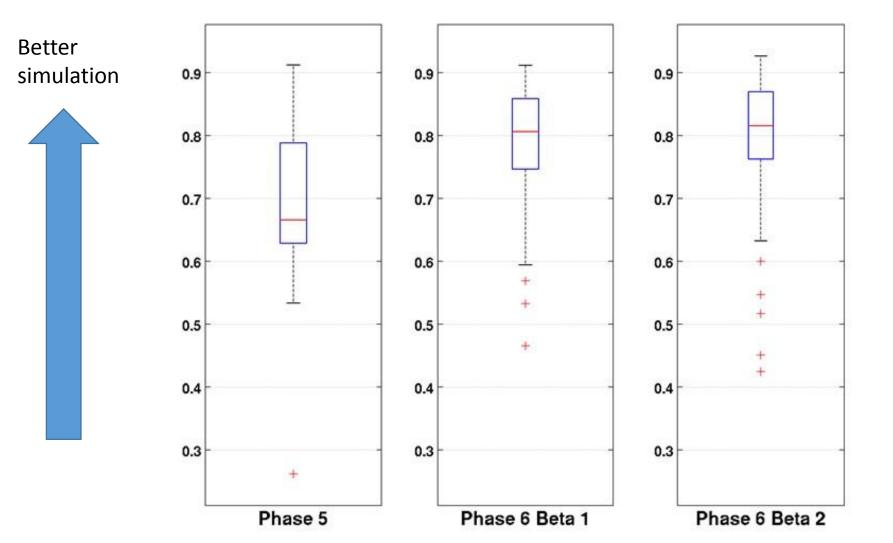
Hydrology



Nitrogen Seasonal Correlation



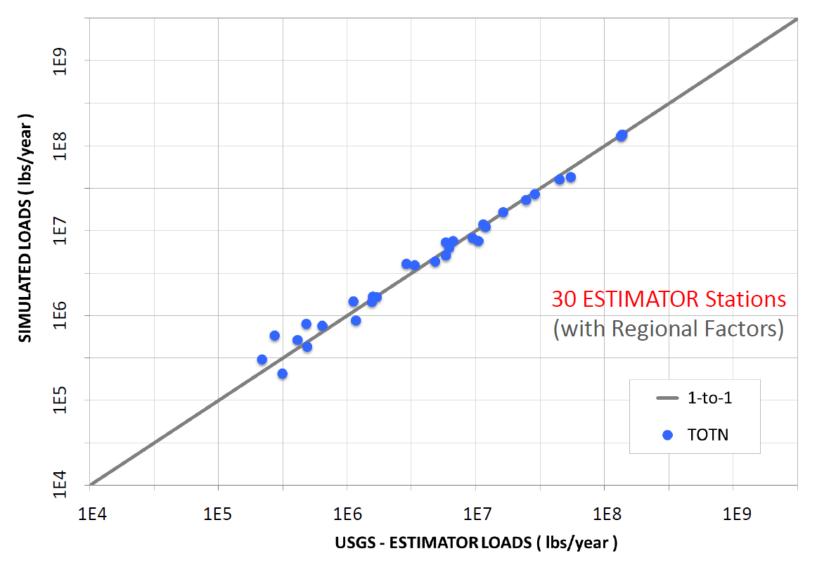
Phosphorus Seasonal Correlation



PHASE 5

NITROGEN

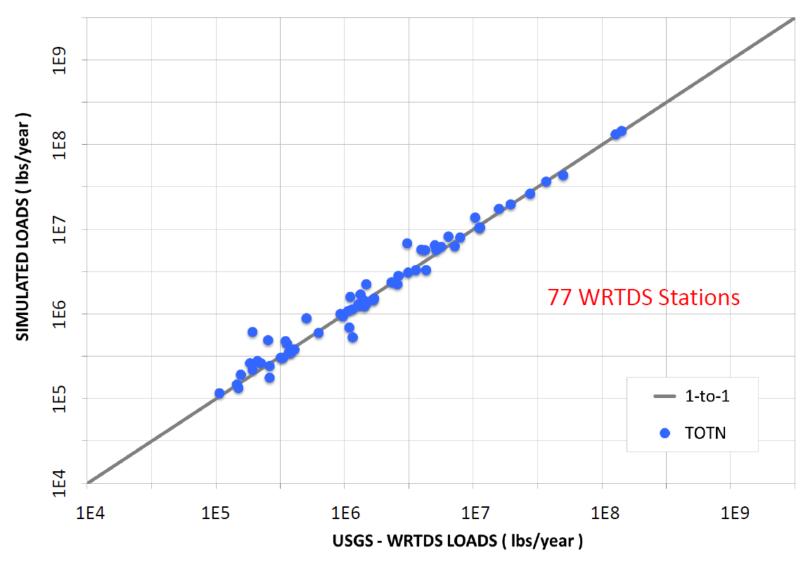
Load





NITROGEN

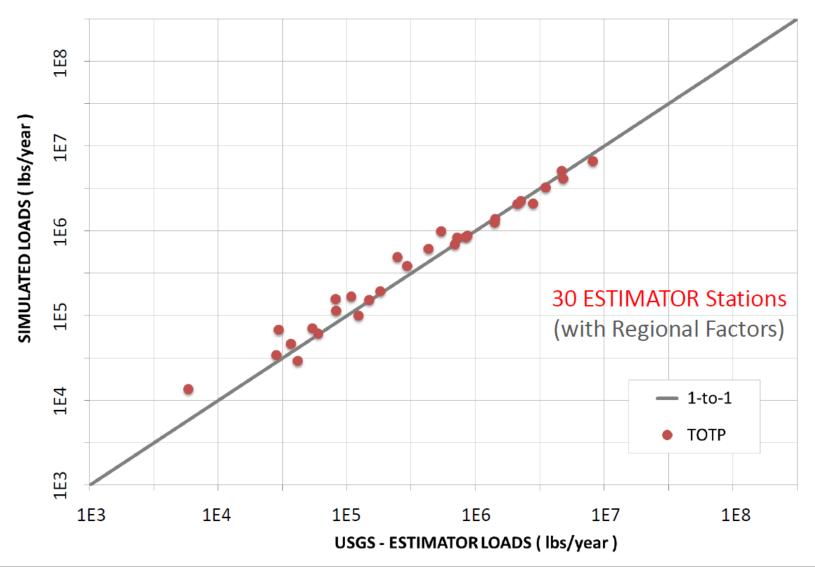




PHASE 5

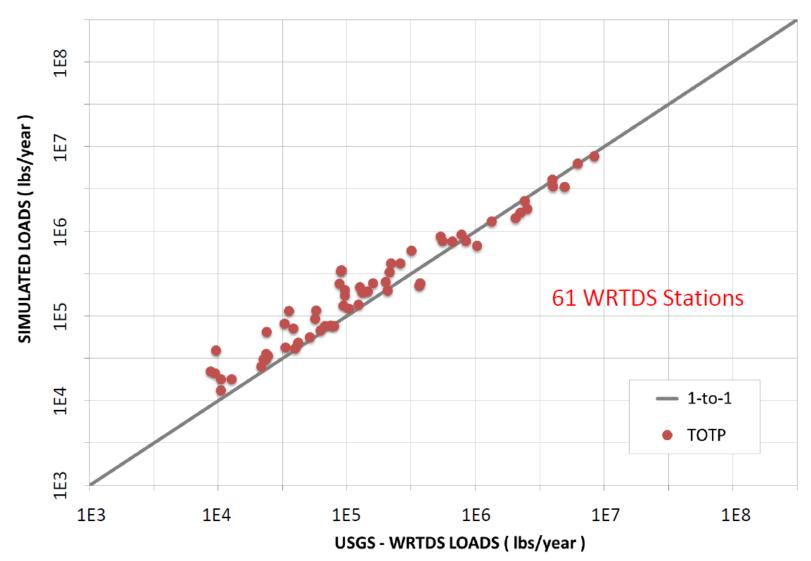
PHOSPHORUS

Load



PHOSPHORUS

Load

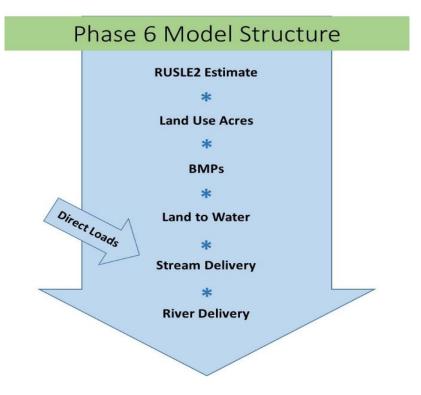


Sediment is similar to nutrients but no sensitivity

Nutrients

Average Load + A Inputs * Sensitivity * Land Use Acres * BMPs * Land to Water * Stream Delivery * River Delivery

Sediment

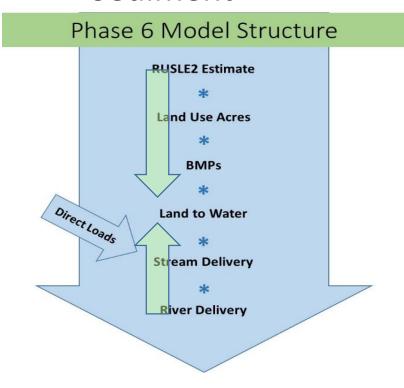


Mass Balance at the L2W step rather than the average load step

Nutrients

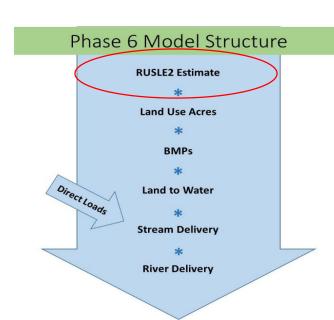
Phase 6 Model Structure Average + Δ Inputs * Sensitivity Land Use Acres **BMPs** Direct Loads Land to Water Stream Delivery **River Delivery**

Sediment



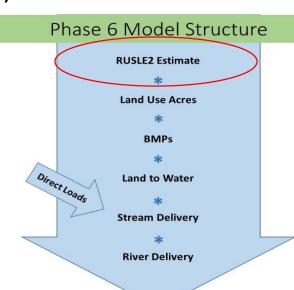
RUSLE2 = Edge-of-Field Loads

- Evaluated at the 10m Pixel Level
- Summarized to LRseg and land use
 - Forest
 - Open Space
 - Crop
 - Pasture
 - Turfgrass
 - Tree Canopy over Turfgrass



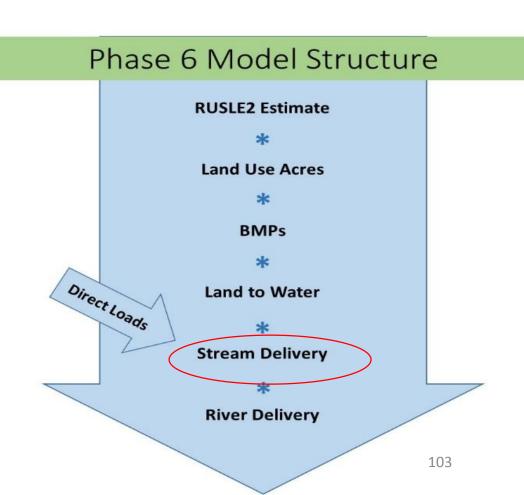
RUSLE2 => A = RKLSCP

- R = Runoff
 - = $1.24P^{1.36}$ P from PRISM
- K = Erodibility
 - from STATSGO and gSSURGO
- LS = slope length
 - = (Flow Accumulation x Cell Resolution / 22.1) $^{0.4}$ x (Sin(Slope x 0.01745) / 0.09) $^{1.4}$ x 1.4
- C = Cover
 - from Tetratech and AgWG
- P = Practice
 - = 1 since no action loads



Stream Delivery – Ag and Natural

- Will be Greg Noe / Peter Claggett stream mass balance
- Assumed to be 1 until completed

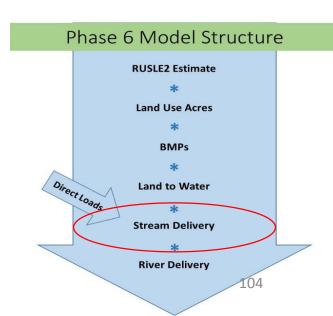


Stream Delivery – Developed

Center for Watershed Protection Work

$$SSR = 1 - \frac{Upland\ Load}{Total\ Watershed\ Load}$$

Stream Source Load = Land Source Load * SSR / (1 - SSR)

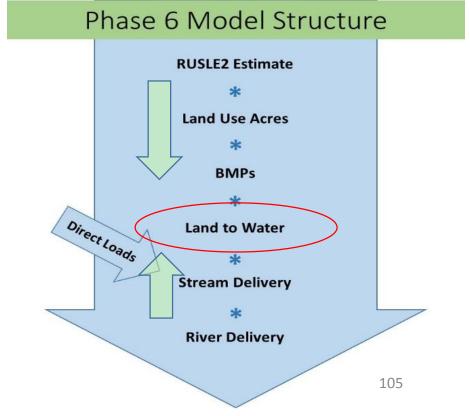


Land to Water – calculate average

• [(RUSLE2 * acres * BMPs * L2W) + SD] * RD = RIM Load

• L2W = [(RIM / RD) - SD] / (RUSLE2 * acres * BMPs)

• L2W = 0.25

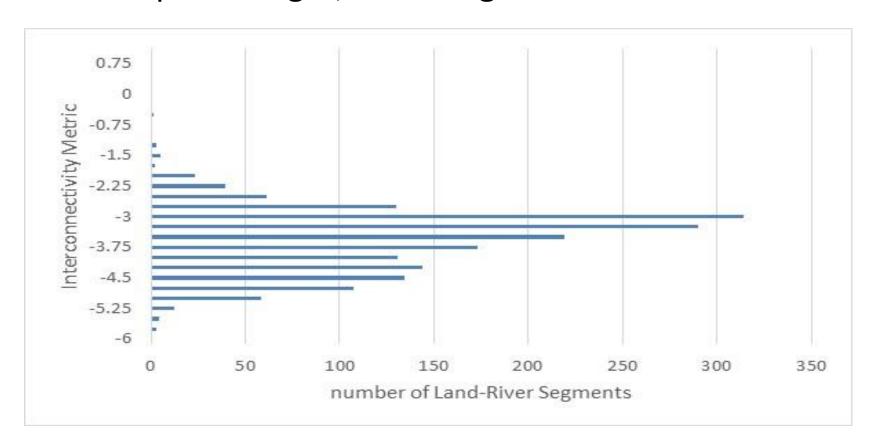








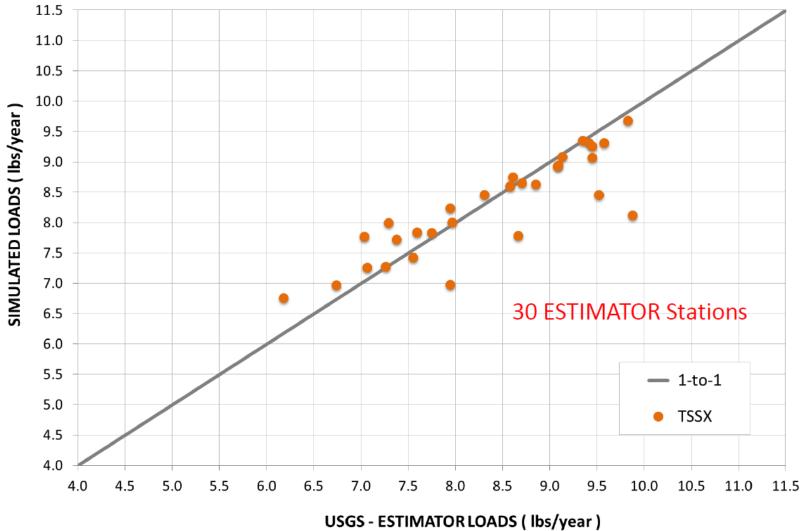
Calculation related to Slope, Area, Flowpath Length, and Roughness



PHASE 5

SEDIMENT

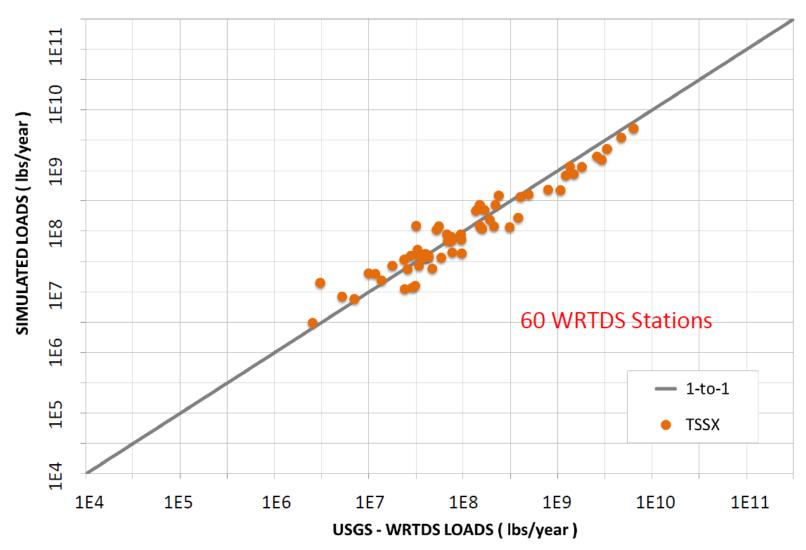
Load



41

SEDIMENT

Load



Non-Tidal Water Quality Dashboard WRTDS/WSM Dashboard

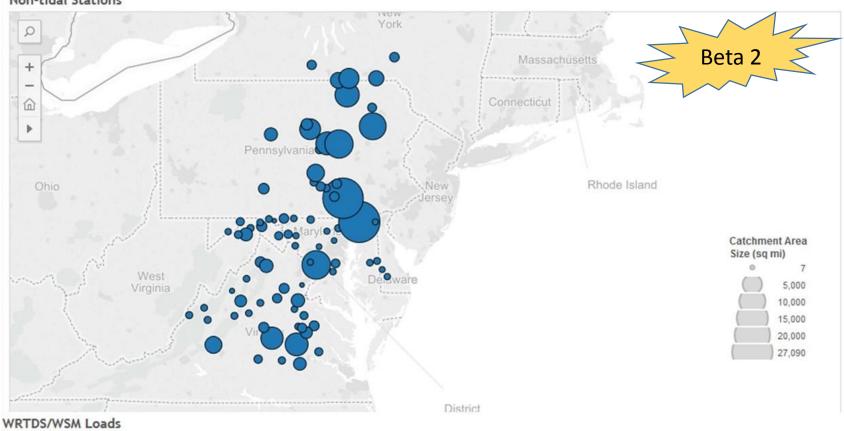
Chesapeake Bay Non-Tidal WRTDS/WSM Data

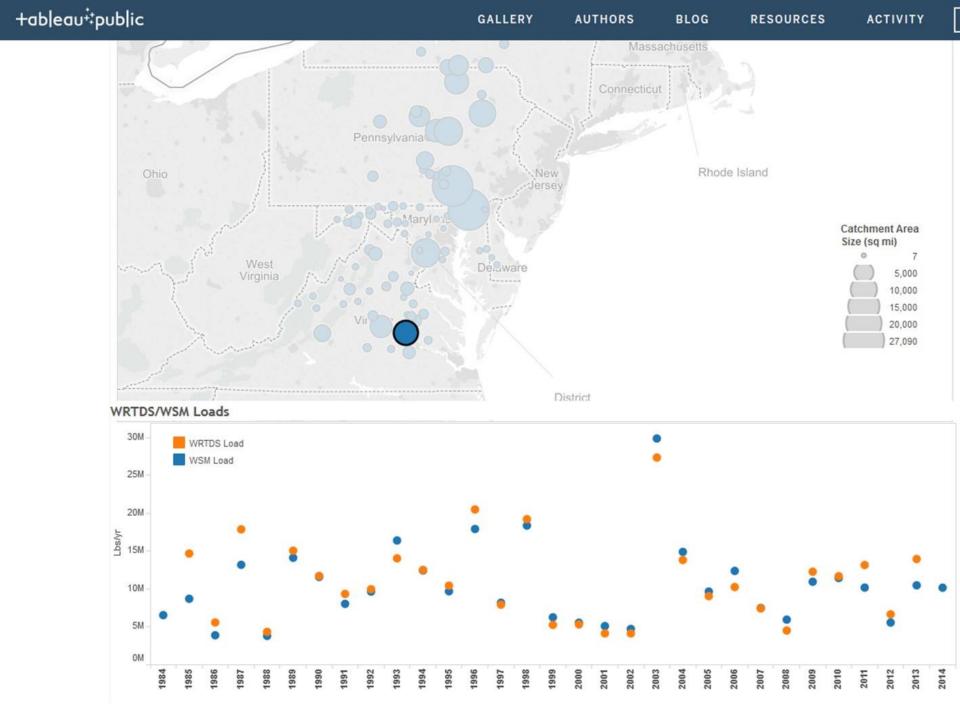
Select a parameter from the dropdown menu, then select a monitoring station from the map. The WRTDS and WSM values will be shown on the chart below. More information on the Watershed Model can be found at: <a href="http://www.chesapeakebay.net/groups/gro

Parameter

Total nitrogen

Non-tidal Stations





Beta 3 updates - August

- Overall Calibration Strategy
 - Examining assumptions throughout model
- Inputs
 - Update nutrient input data methods
 - Biosolids as a separate input
- Watershed representation
 - 8 new impoundments and reservoirs
 - rSAS model for simulating groundwater nitrate lags
- Scenarios a few key scenarios

Beta 4 updates - December

- Overall Calibration Strategy
 - Examining assumptions throughout model
- Inputs
 - Updated nutrient inputs
 - Atmospheric deposition dataset
 - BMP history
 - BMP effects
- Watershed representation
 - Streambed and Shoreline loads
 - Representation of Conowingo
 - rSAS model for simulating groundwater nitrate lags
 - Updated Sparrow factors
- Scenarios climate change

Phase 6 updates – April 2017

- Inputs
 - Land use

... and that's it

Review Strategy

- Read section 1 of the documentation to understand the overall structure
 - Determine the sections in the documentation that are most relevant to your work or interest in the Chesapeake Bay Program partnership.
- Review sections of interest to comment on
 - Quality of documentation
 - Overall concept used to calculate model values
 - Calculation methods used to determine model values
 - Data used
 - Long-term suggestions for future models.
- Review the calibration relative to concentrations and loads
 - Summary flow statistics
 - Summary of agreement between WRTDS and Phase 6 overall
 - Review particular stations of interest to your jurisdiction.
- Review scenarios (B3, B4)
 - Broad Scale Relative ranking of scenarios
 - The aggregate effect of BMPs
 - The effects of inputs, such as land use, animal numbers, etc.

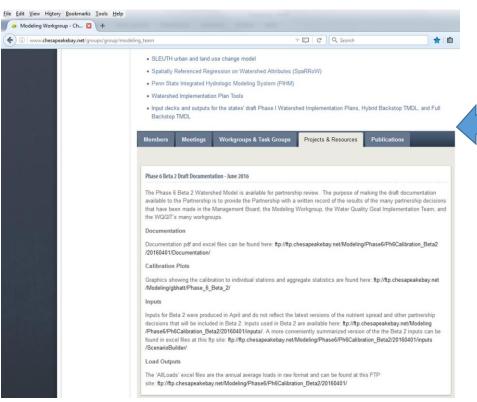
Evaluation Focus — Model Performance

- Is the model simulating the processes correctly?
- Is the model performing reasonably with respect to observations?
 - RIM stations, large watersheds to smaller
 - Annual loads
 - Seasonal performance
 - B1 vs. P5, B2 vs. B1, B3 vs. B2.....
- Model trends vs observed trends
- How is the model performing in management scenarios?
 - Are BMPs reducing loads? sounds simple, but important
 - Do the ordinal ranking of scenarios make sense?
- Temperance, not perfect but reasonable

How to get more information

Modeling Workgroup website on Chesapeakebay.net

Scroll down to 'projects & resources' tab



Set up a statespecific meeting



Discussion.....